

A REVIEW OF THE GENUS EMPOASCA (HOMOPTERA:
CICADELLIDAE) REPORTED FROM NORTHEAST KANSAS

by

Roxanne A. Fegley

A.S., Jamestown Community College, 1984

B.S., State University of New York at Fredonia, 1986

A THESIS

submitted in partial fulfillment of the

requirements for the degree

Master of Science

College of Agriculture
Department of Entomology

Kansas State University
Manhattan, Kansas

1989

Approved by:


Major Professor

TABLE OF CONTENTS

A11208 301922

| | |
|---|-----|
| LIST OF TABLES AND FIGURES | iii |
| ACKNOWLEDGMENTS | v |
| INTRODUCTION | 1 |
| MATERIALS AND METHODS | 3 |
| EVOLUTIONARY RELATIONSHIPS | 9 |
| KEY TO THE MALES OF <u>EMPOASCA</u> , <u>KYBOS</u> , AND <u>KYBOASCA</u> FROM NORTHEAST KANSAS | 16 |
| GENUS <u>KYBOS</u> | 19 |
| <u>Kybos grosata</u> (DeLong and Davidson) | 19 |
| <u>Kybos gelbata</u> (DeLong and Davidson) | 21 |
| <u>Kybos jacinta</u> (DeLong and Davidson) | 23 |
| <u>Kybos obtusa</u> (Walsh) | 24 |
| GENUS <u>KYBOASCA</u> | 27 |
| <u>Kyboasca denticula</u> (Gillette) | 27 |
| <u>Kyboasca pergandei</u> (Gillette) | 29 |
| GENUS <u>EMPOASCA</u> | 31 |
| <u>Empoasca (Solanasca) solana</u> DeLong, new status | 31 |
| <u>Empoasca (Empoasca) decurvata</u> Davidson and DeLong | 32 |
| <u>Empoasca (Empoasca) curvata</u> Poos | 34 |
| <u>Empoasca (Empoasca) alboneura</u> Gillette | 35 |
| <u>Empoasca (Empoasca) esuma</u> Goding | 37 |
| <u>Empoasca (Empoasca) vergena</u> DeLong and Caldwell | 38 |
| <u>Empoasca (Empoasca) bifurcata</u> DeLong | 41 |
| <u>Empoasca (Empoasca) erigeron</u> DeLong | 43 |

FENTM

1981

F44

C 2

| | |
|---|----|
| <u>Empoasca (Empoasca) recurvata</u> DeLong | 45 |
| <u>Empoasca (Empoasca) pallida</u> Gillette | 47 |
| <u>Empoasca (Empoasca) fabae</u> (Harris) | 49 |
| <u>Empoasca (Empoasca) sativae</u> Poos | 51 |
| LITERATURE CITED | 53 |
| Appendix A | 75 |

LIST OF TABLES AND FIGURES

TABLES

| | |
|--|---|
| 1. Leafhoppers collected from alfalfa field on Barnes Road, Pottawatomie County, Kansas | 5 |
| 2. Leafhoppers collected from wooded area at Tuttle Creek Dam Observation Point, Riley County, Kansas | 7 |
| 3. Leafhoppers collected from grassland on Marlatt Avenue, Riley County, Kansas | 8 |

FIGURES

| | |
|---|----|
| 1. <u>Kybos grosata</u> (DeLong and Davidson) | 56 |
| 2. <u>Kybos gelbata</u> (DeLong and Davidson) | 57 |
| 3. <u>Kybos jacinta</u> (DeLong and Davidson) | 58 |
| 4. <u>Kybos obtusa</u> (Walsh) | 59 |
| 5. <u>Kyboasca denticula</u> (Gillette) | 60 |
| 6. <u>Kyboasca pergandei</u> (Gillette) | 61 |
| 7. <u>Empoasca (Solanasca) solana</u> DeLong, new status | 62 |
| 8. <u>Empoasca (Empoasca) decurvata</u> Davidson and DeLong | 63 |
| 9. <u>Empoasca (Empoasca) curvata</u> Poos | 64 |
| 10. <u>Empoasca (Empoasca) alboneura</u> Gillette | 65 |
| 11. <u>Empoasca (Empoasca) esuma</u> Goding | 66 |
| 12. <u>Empoasca (Empoasca) vergena</u> DeLong and Caldwell | 67 |
| 13. <u>Empoasca (Empoasca) bifurcata</u> DeLong | 68 |
| 14. <u>Empoasca (Empoasca) erigeron</u> DeLong | 69 |
| 15. <u>Empoasca (Empoasca) recurvata</u> DeLong | 70 |

| | |
|---|----|
| 16. <i>Empoasca</i> (<i>Empoasca</i>) <i>pallida</i> Gillette | 71 |
| 17. <i>Empoasca</i> (<i>Empoasca</i>) <i>fabae</i> (Harris) | 72 |
| 18. <i>Empoasca</i> (<i>Empoasca</i>) <i>sativae</i> Poos | 73 |
| 19. Intuitive phylogeny graphically represented using MacClade..... | 74 |
| 20. Phylogeny developed using CLINCH | 77 |

ACKNOWLEDGMENTS

The author acknowledges Dr. H. Derrick Blocker, under whose direction this work was done, for suggesting this study, for his guidance, encouragement and patience. Dr. Richard J. Elizinga and Dr. David C. Margolies, other members of the author's graduate committee, are acknowledged for their suggestions and critical review of the manuscript.

This research was supported by Kansas State University Agricultural Experimental Station Hatch project H033 entitled "Biosystematics of Insects and Arachnids".

Dr. Robert G. Helgesen, Head, Department of Entomology, is acknowledged for his interest and support of this research.

The author is grateful to the following individuals and institutions for lending specimens on which the major portion of this work was based: Dr. George W. Byers and Dr. Robert Brooks, specimens from the Snow Entomological Museum at the University of Kansas; Dr. Charles A. Triplehorn, specimens from The Ohio State University Entomological Museum; and Thomas J. Henry, specimens from the United States National Museum.

I would also like to thank Dr. George W. Byers and Dr. Robert Brooks for providing access to type specimens and study facilities on many occasions at the University of Kansas.

The author gratefully acknowledges the patience, encouragement and assistance of her future husband, Kevin A. Shufren.

Introduction

Empoasca species utilize a great variety of domesticated and wild plant species and many are considered economically important. Some species are host specific, such as E. ricei Dworakowska and Pawar on rice (Sohi 1983), while many others are not. E. fabae may feed on several hundred species of plants and is considered the single most important economic species of Empoasca because of its damage to cultivated and wild host plants (DeLong 1931a).

Empoasca, the type genus of the tribe Empoascini, was described by Walsh in 1862. In the Western hemisphere, nearly 460 nominal species have been assigned to Empoasca (Southern 1982). Species descriptions are scattered throughout the literature, yet no comprehensive key has been attempted since DeLong's (1931) key to Empoasca of America north of Mexico.

Species of the tribe Empoascini are so similar in external appearance that accurate identification to genus and/or species by external characters is nearly impossible. Characters which have been used by previous authors, such as external male genitalia, pygofer and anal tube processes, and abdominal apodemes, offer the most significant characters for generic and specific delineation and identification (Cunningham 1962, Hamilton 1972, Southern 1982). These structures are used as taxonomic characters because of their highly complicated structure and often, their species-specific configuration. Anal hook (also known as anal tube process) shape is the most important character used. Style shape, size and shape of the abdominal apodemes, and aedeagal processes are also used to differentiate species. Other characters are not ignored, but their use is mainly supplementary. For

general illustrations of these characters, see Cunningham (1962) and Southern (1982).

Generic and subgeneric classification of Empoasca is subject to controversy. Cunningham (1962) and Ross (1963) regard Kyboasca and Kybos as subgenera of Empoasca, while Anufriev (1978) and Viraktamath (1988 pers. comm) regard Kyboasca and Kybos as separate genera. Some researchers choose to disregard subgenera altogether (Young 1952b and Southern 1982), while others (Cunningham 1962, Hamilton 1972, and Sohi and Dworakowska 1983) use subgeneric classifications. Young (1952b) divided Western Hemisphere species into species groups and species of uncertain position. Southern (1982) did not place Empoasca of Eastern Peru in subgenera but points out that all species in his study could be placed in the subgenus Empoasca as recognized by Cunningham (1962), Ross (1963) and Hamilton (1972).

A world revision of the economically important genus Empoasca is needed (Viraktamath 1983). A review of the genus from Northeastern Kansas represents a starting point for a future systematic endeavor on the genus of other geographic areas. The objectives of this research were: (1) to develop a taxonomic key to species reported in Northeastern Kansas; (2) to provide a species level review of Empoasca reported in Northeastern Kansas using two related genera for outgroup comparisons; (3) to expand and further identify the distributional knowledge of each species, principally by using the collection labels which accompany specimens acquired on loan; (4) to collect from Kansas in order to determine what species of Empoasca are present in local fauna and augment research collections; and (5) to establish methodology for phylogenetic analysis.

Materials and Methods

Keys, descriptions, and evolutionary relationships were developed using specimens obtained from Kansas State University (KSU), The University of Kansas (KU), The Ohio State University (OSU), and the United States National Museum (USNM). Two Empoascini genera reported from Northeast Kansas, Kyboasca and Kybos, were included in this study for outgroup comparisons. Many specimens used in this study were not collected in Kansas but the species have been reported in Kansas.

I only illustrated males due to the lack of reliable female characters and because females could not always be dependably associated with males. The only significant female character is the shape of the posterior margin of the seventh sternum which sometimes is variable and therefore should be used with caution. I also found many male specimens to be misidentified.

Most specimens were dissected to ensure that all individuals in a series represented the same species. Entire abdomens were removed and cleared in a 10% potassium hydroxide solution. After clearing, the abdomens were rinsed for approximately 10 minutes in distilled water and stained with an acid fuchsin stain. Excess stain was removed by rinsing with distilled water. Abdomens were then placed in a depression slide with glycerin for viewing. Further dissection was not needed because of the exoskeleton's transparent nature.

To immobilize the abdomen for drawing, a very small amount of boric acid ointment was smeared in the bottom of a depression slide and glycerin was added (Young 1952b). Illustrations of the head, pronotal, abdominal, and genitalic structures were made using a compound microscope, an ocular grid, and coordinate

paper. All drawings were made at a magnification of 8X unless specified otherwise. After study, the abdomen was placed in a genitalia vial with glycerin. A styrene stopper was placed in the vial and the pin bearing the specimen was thrust diagonally through the stopper.

Measurements were made under the compound microscope using an ocular micrometer. Terminology and dimensions reported follow Southern (1982) and Cunningham (1962) and were taken in the flattest aspect. Body length was measured from the anterior margin of the crown to the posterior tip of the forewings. Crown length extended medially from the anterior margin to the anterior margin of the pronotum. Crown production was measured from the anterior margin, along the midline, to a point on an imaginary line joining the anterior margins of the compound eyes. Interocular width extended at the least width between the eyes. Pronotal length was measured medially from the anterior to the posterior margin; Width extended along the greatest width of the pronotum.

Abdominal apodeme size and shape are also of taxonomic value. Apodeme lengths extended from the base to the posterior margin of one lobe. Apodeme widths were measured from the outer margin of the left lobe to the outer margin of the right lobe at the base of the apodeme.

Field collections of Empoasca species were made to augment existing distributional knowledge. An alfalfa field, wooded area, and grassland area were sampled using a sweepnet. Five collections of five minutes each were made at each site. Samples were collected monthly from May through August 1987 and June through July 1988. The alfalfa field was located on Barnes Road in Pottawatomie County, Kansas (Table 1). The wooded area was located at the Tuttle Creek Dam Observation Point in Riley County, Kansas (Table 2). The grassland area was

located on Marlatt Avenue in Riley County, Kansas (Table 3).

Table 1. Leafhoppers collected from alfalfa field on Barnes Road, Pottawatomie County, Kansas

| Date | Species | No. Collected |
|-----------|--------------------------------|---------------|
| May 1987 | <i>Macrosteles fascifrons</i> | 38 |
| | <i>Empoasca fabae</i> | 17 |
| | <i>Endria inimica</i> | 3 |
| | <i>Scaphytopius</i> sp. | 3 |
| | <i>Draeculacephala</i> sp. | 2 |
| | <i>Paraphlepsius irroratus</i> | 2 |
| | <i>Exitianus exitiosus</i> | 1 |
| | | <hr/> 66 |
| June 1987 | <i>Macrosteles fascifrons</i> | 36 |
| | <i>Exitianus exitiosus</i> | 8 |
| | <i>Erthyronura</i> sp. | 5 |
| | <i>Draeculacephala</i> sp. | 2 |
| | <i>Endria inimica</i> | 2 |
| | <i>Balclutha</i> sp. | 1 |
| | <i>Gyponinae</i> | 1 |
| | | <hr/> 55 |
| July 1987 | <i>Balclutha</i> sp. | 67 |
| | <i>Exitianus exitiosus</i> | 19 |
| | <i>Scaphytopius</i> sp. | 7 |
| | <i>Draeculacephala</i> sp. | 4 |
| | <i>Endria inimica</i> | 1 |
| | <i>Parabolacratrus</i> sp. | 1 |
| | <i>Macrosteles fascifrons</i> | 1 |
| | | <hr/> 100 |

Table 1. contd.

| Date | Species | No. Collected |
|-----------|------------------------------------|---------------|
| Aug 1987 | <i>Empoasca fabae</i> | 32 |
| | <i>Endria inimica</i> | 21 |
| | <i>Agallia</i> sp. | 10 |
| | <i>Macrosteles fascifrons</i> | 6 |
| | <i>Graphocephala hieroglyphica</i> | 5 |
| | <i>Exitianus exitiosus</i> | 2 |
| | Undetermined | 2 |
| | <i>Draeculacephala</i> sp. | 1 |
| | | 79 |
| June 1988 | <i>Empoasca fabae</i> | 58 |
| | <i>Graminella</i> sp. | 52 |
| | <i>Exitianus exitiosus</i> | 13 |
| | Undetermined | 2 |
| | <i>Gypona</i> sp. | 1 |
| | <i>Graphocephala hieroglyphica</i> | 1 |
| | <i>Scaphytopius</i> sp. | 1 |
| | | 128 |
| July 1988 | <i>Empoasca fabae</i> | 31 |
| | <i>Exitianus exitiosus</i> | 3 |
| | <i>Balclutha</i> sp. | 1 |
| | <i>Stirellus bicolor</i> | 1 |
| | | 36 |

**Table 2. Leafhoppers collected from wooded area at Tuttle Creek Dam
Observation Point, Riley County, Kansas**

| Date | Species | No. Collected |
|-----------|-------------------------------|---------------|
| May 1987 | <i>Endria inimica</i> | 5 |
| | <i>Empoasca fabae</i> | 1 |
| | <i>Exitianus exitiosus</i> | 1 |
| | <i>Paraphlepsius</i> sp. | 1 |
| | <i>Xestocephalus</i> sp. | 1 |
| | | <hr/> 9 |
| June 1987 | <i>Erythroneura</i> sp. | 42 |
| | Undetermined | 12 |
| | <i>Exitianus exitiosus</i> | 3 |
| | <i>Endria inimica</i> | 2 |
| | <i>Balclutha</i> sp. | 1 |
| | <i>Paraphlepsius</i> sp. | 1 |
| | | <hr/> 61 |
| July 1987 | <i>Erythroneura</i> sp. | 6 |
| | <i>Graphocephala</i> sp. | 1 |
| | | <hr/> 7 |
| Aug 1987 | <i>Erythroneura</i> sp. | 13 |
| | <i>Empoasca fabae</i> | 6 |
| | | <hr/> 19 |
| June 1988 | <i>Erythroneura</i> sp. | 13 |
| | <i>Macrostelus fascifrons</i> | 2 |
| | | <hr/> 15 |
| July 1988 | NONE COLLECTED AREA BURNED | |

Table 3. Leafhoppers collected from grassland area on Marlatt Avenue, Riley County, Kansas

| Date | Species | No. Collected |
|-----------|-------------------------------|---------------|
| May 1987 | <i>Macrosteles fascifrons</i> | 15 |
| | <i>Exitianus exitiosus</i> | 2 |
| | <i>Endria inimica</i> | 1 |
| | Undetermined | 1 |
| | | <hr/> 19 |
| June 1987 | <i>Macrosteles fascifrons</i> | 26 |
| | Undetermined | 6 |
| | <i>Exitianus exitiosus</i> | 5 |
| | <i>Graphocephala</i> sp. | 3 |
| | <i>Balclutha</i> sp. | 2 |
| | <i>Draeculacephala</i> sp. | 2 |
| | <i>Stirellus bicolor</i> | 2 |
| | <i>Endria inimica</i> | 1 |
| | <i>Scaphytopius</i> sp. | 1 |
| | | <hr/> 48 |
| July 1987 | <i>Balclutha</i> sp. | 74 |
| | <i>Graminella</i> sp. | 23 |
| | <i>Exitianus exitiosus</i> | 6 |
| | <i>Parabolacratrus</i> sp. | 5 |
| | <i>Scaphytopius</i> sp. | 4 |
| | <i>Stirellus bicolor</i> | 4 |
| | <i>Draeculacephala</i> sp. | 1 |
| | <i>Paraphlepsius</i> sp. | 1 |
| | | <hr/> 118 |
| Aug 1987 | NONE COLLECTED AREA DRY | |

Table 3. contd.

| | | |
|-----------|------------------------|----|
| June 1988 | Graminella sp. | 60 |
| | Undetermined | 5 |
| | Gyponinae | 1 |
| | Macrosteles fascifrons | 1 |
| | | 67 |
| July 1988 | Gyponinae | 11 |
| | Scaphytopius sp. | 2 |
| | Agallia sp. | 1 |
| | Hecalinae | 1 |
| | Undetermined | 1 |
| | | 16 |

Two phylogenetic computer software packages were used to provide three functions: 1.) comparison with my intuitive phylogeny, 2.) graphical representation, and 3.) tree length calculation. The first package used was CLINCH version 6.2 developed by Kent L. Fiala (Appendix A). The second package used was MacClade version 2.1 developed by Wayne and David Maddison.

For a complete bibliography through 1955, see Metcalf (1967). All related literature from 1956 to 1988 as well as other selected references are included herein.

Evolutionary Relationships

Characters other than external male genitalia, anal hooks, and pygofer and abdominal processes are either not diagnostic within the three genera studied in this research, are different in only one of the three genera, or consist of only slight differences. Head and pronotal characters are variable. Crown production in Northeast Kansas species is consistently less in *Kyboasca* than in *Kybos* and *Empoasca*. Production of the crown is consistent within the latter two genera. Crown length, interocular width, pronotal length, and pronotal width are consistent

in all three genera. Coloration is of little taxonomic value because of infraspecific variability and fading of old specimens.

Similarity among females of different species makes association of males and females of the same species difficult. When females can be identified, species descriptions contain information that distinguishes them. Also, females cannot be determined to genus, thus one should be convinced of the female's association with male specimens before attempting identification.

During taxonomic consideration of Empoasca from Northeast Kansas I speculated on the phylogenetic standing of the taxa involved. Ideally, all species of the genus should be studied before a phylogeny can be constructed and therefore only a general discussion concerning the evolution of the species studied here is presented. For outgroup comparisons I studied the genera Kybos and Kyboasca of Northeast Kansas.

I am aware of only one person, Cunningham (1962), who has attempted a phylogeny of the genus Empoasca and his study included only 54 nominal species. Probably the main reason for the lack of phylogenetic speculation is the large number (600-700) and worldwide distribution of species. The number and distribution of Empoasca species is, as Southern (1982) describes, "... sobering if not discouraging." Adding to the problem is the generic controversy within Empoasca. Asian and African species exhibit the same hind wing venation used to determine members of Empoasca of the Western hemisphere but differ greatly in the shape of the male genital capsule and external male genitalia. Southern (1982) suggests new limits be developed for the genus based on external male genitalia. He also points out that this would entail study of the world fauna and would be an extremely large project.

Character polarity is an important aspect in this research. First, the genus Kyboasca is considered the most ancestral genus of the three considered. Characters used to support the ancestral nature of Kyboasca are the presence of the following pleisomorphic characters: a crown with the medial length approximately equal to the crown length at the sides, anal hooks short, flat, lightly sclerotized with bases not connected, triangular pygofer, and few or no setae on the styles (Cunningham 1962). Cunningham regarded Kyboasca as a subgenus but I follow Anufriev (1978) who elevated Kyboasca to a genus and who is presently being accepted by other researchers.

Hamilton (1983) points out that synapomorphic (derived characters in common) rather than sympleisomorphic (ancestral characters in common) characters should be used to group organisms. Synapomorphic characters used to determine members of Kyboasca include much reduced second sternal apodemes, presence of tergal apodemes on segments IV, V, VI and in some species on segment VII, and long, straight, gradually tapered style bodies with the dentifers not greatly differentiated from the bodies.

Sympleisomorphic characters of the genera Kybos and Empoasca include well developed second sternal apodemes, third tergal apodemes present only as narrow, transverse ridges, and styles with the dentifer differentiated from the body. Synapomorphic characters of these two genera include a longer crown medially than at the sides, rounded pygofer, large caudodorsal lobe on the plates, anal hooks with bases connected around the dorsal base of the tenth segment. Kybos differs from Empoasca in the presence of derived long, numerous, and fine setae on the styles.

My postulated evolution of Northeast Kansas members of Kyboasca follows Cunningham's (1962) assessment of character polarity. Both K. denticula

(Gillette) and pergandei (Gillette) retain the ancestral crown with front and hind margins parallel, basally unconnected and short, flat, lightly sclerotized anal hooks, triangular pygofer, and few, short setae on the styles. K. denticula is considered more ancestral than pergandei. K. denticula has more ancestral shorter tergal IV - VII abdominal apodemes. K. pergandei has more derived longer tergal IV - VII abdominal apodemes.

Cunningham (1962) regards the crown of Kybos as ancestral. I do not agree with this assessment. The crowns of Kybos members that I studied were longer in the middle than at the sides. Cunningham (1962) regards this condition as derived.

Northeast Kansas members of Kybos may be divided into two species lines. Members of the butleri line have A-group plate setae that are comblike in appearance. The butleri line is considered more derived than the trifasciata line which has no setal comb. Within the butleri line, K. grosata (DeLong and Davidson) has a derived pair of stout lateral lobes arising at the base of the aedeagus shaft. K. gelbata (DeLong and Davidson) retained the ancestral simple aedeagus shaft. Long and slender derived anal hooks are used to separate members of the trifasciata line. K. jacinta (DeLong and Davidson) has long and slender anal hooks while obtusa (Walsh) retains ancestral short and broad anal hooks.

The genus Empoasca may be divided into two subgenera, Empoasca (Empoasca) and Empoasca (Solanasca). The subgenus Empoasca may be further divided into two species lines. The fabae line has derived dentifers that are either straight or directed dorsally in lateral view. Members of the second line, the erigeron line, retained ventrally directed dentifers.

Two groups within the fabae line are recognized. One group has developed long and slender anal hooks while the second group retained short and broad anal hooks.

The first group is ultimately divided into two species; E. recurvata DeLong which has developed a lobe on the caudoventral margin of the pygofer and pallida Gillette which has retained a pygofer without a caudoventral lobe. Two species from Northeast Kansas are recognized in the second group, E. fabae (Harris) and sativae Poos. E. fabae has reduced second sternal apodemes which are considered derived. Second sternal apodemes that extend past segment four have been retained by E. sativae.

The erigeron line may be further subdivided into two species groups. The esuma species group contains species which have become specialized in the loss or reduction of the large caudodorsal lobe on the plates. The caudodorsal lobe on the plates has been retained by the cerea species group.

Five species studied in the esuma species group appear to represent members of two monophyletic groups. One group derived brachones that cross at least once, at or very near the midpoint. The brachones of the other group only cross once near the apical ends or do not cross at all. Representing the first group, E. decurvata Davidson and DeLong has derived long and slender anal hooks while curvata Poos has retained short and broad anal hooks. The second group contains three species. E. alboneura Gillette has reduced and triangular second sternal apodemes. E. esuma Goding has developed long and slender anal hooks while vergana DeLong and Caldwell has retained short and broad anal hooks.

Two species represent the cerea species group in Northeast Kansas. As in many previously mentioned cases, anal hook shape is used to separate these two species. E. bifurcata DeLong has specialized anal hooks which are, as the name suggests, bifurcate. E. erigeron DeLong has retained simple unforked anal hooks.

Ghuri (1974) elevated E. solana, the 24 species of the solana group from

Ross and Cunningham's (1960) key, one species described by Langlitz (1964), and a new species he described, to the new genus, Solanasca. Characters Ghauri used to support this elevation were the presence of ventral aedeagal processes and simple, rounded, and weakly sclerotized anal hooks. My present knowledge of Empoasca and related groups leads me to believe Ghauri's elevation should have been only to the subgeneric level not to the generic level. Drawings of E. (Matsumurasca) diversa Vilbaste (Anufriev 1978) and S. dominica Ghauri (Ghauri 1974) suggest that ventral aedeagal processes are present in both Anufriev's subgenus Matsumurasca and Ghauri's genus Solanasca. Matsumurasca and Solanasca differ in anal hook structure. E. (M.) diversa has apically long and slender anal hooks while S. dominica has simple, rounded, and weakly sclerotized anal hooks. The anal hooks of E. fabae and solana are similar except for the presence of a short, spine-shaped apex on the anal hook of fabae. The anal hook apex of E. solana is bluntly rounded. I do not think the anal hook difference is enough evidence to support elevating Solanasca to the generic level and therefore I place Solanasca at the subgeneric level.

The subgenus Solanasca probably evolved parallel to the fabae line. Both the subgenus Solanasca and the fabae line, as considered in my research, have some species with reduced sternal II apodemes and some species with sternal II apodemes not reduced. In both Solanasca and the fabae line some species have narrow, transverse tergal III apodemes and some species have slighter larger, crescentic tergal III apodemes.

Characters and weights used in my intuitive analysis (from ancestral to derived)

| | Characters | Weights |
|----|--------------------------------------|---------|
| 1 | Few, short or no setae on the styles | x 5 |
| 1' | Many, long setae on the styles | |

| | | |
|-----|---|-----|
| 2 | Tergal apodemes absent or present only on segment III | x 5 |
| 2' | Tergal apodemes present on segments III - VI | |
| 3 | Anal hook bases not connected | x 5 |
| 3' | Anal hook bases connected | |
| 4 | Setal comb absent | x 3 |
| 4' | Setal comb present | |
| 5 | Aedeagus without lateral processes | x 4 |
| 5' | Aedeagus with lateral processes | |
| 6 | Anal hooks short and broad | x 1 |
| 6' | Anal hooks long and slender | |
| 7 | Tergal apodeme VII absent or present but short | x 1 |
| 7' | Tergal apodeme VII present and long | |
| 8 | Dentifer apically directed ventrally | x 3 |
| 8' | Dentifer apically directed dorsally or straight | |
| 9 | Caudodorsal lobe on plate present and not reduced | x 2 |
| 9' | Caudodorsal lobe on plate absent or reduced | |
| 10 | Shape of sternal II apodeme other than triangular | x 1 |
| 10' | Shape of sternal II apodeme triangular | |
| 11 | Brachones cross only once near apex or not at all | x 1 |
| 11' | Brachones cross at least once near midpoint | |
| 12 | Anal hooks not bifurcate | x 1 |
| 12' | Anal hooks bifurcate | |
| 13 | Aedeagus processes absent | x 1 |
| 13' | Aedeagus processes present | |
| 14 | Caudovernal lobe absent on pygofer | x 1 |
| 14' | Caudovernal lobe present on pygofer | |
| 15 | Sternal II apodeme attains or exceeds segment V | x 1 |
| 15' | Sternal II apodeme absent or not attaining segment V | |

| | | |
|-----|--|-----|
| 16 | Tergal III apodeme absent or a narrow transverse ridge | x1 |
| 16' | Tergal III apodeme present and longer than a narrow transverse ridge | |
| 17 | Style body not gradually tapered to the dentifer | x 1 |
| 17' | Style body gradually tapered to the dentifer | |
| 18 | Pygofer triangular | x 1 |
| 18' | Pygofer not triangular | |

Characters 1,2, and 3 with weights of x 5 distinguish genera. Subgenera are distinguished by character 5 with a weight of x 4. Species lines are distinguished by characters 4 and 8, each with a weight of x 3. Species groups are distinguished by character 9 with a weight of x 2. I developed an intuitive phylogeny (Figure 19) using the above characters and weights. MacClade was used in this study only as a graphics package and to determine treelength (53) of my intuitive phylogeny.

As noted earlier, a great deal of work remains to be done on the phylogenetic relationships within the tribe Empoascini and generic limits need to be better defined. To develop the best phylogeny of this group a world revision is needed. As previously stated this will be a very large undertaking. My research represents a beginning to this large project.

KEY TO THE MALES OF EMPOASCA, KYBOS, and KYBOASCA FROM NORTHEAST KANSAS

GENERA

1. a. Styles with numerous, long setae 3 Kybos Fieber
- b. Styles with few, short or no setae 2

2. a. Sternal II apodemes reduced and apodemes present on
tergal III, IV, V, VI, and some species with apodemes
present on tergal VII 6 Kyboasca Zachvatkin
- b. Without apodemes on tergal III, IV, V,
and VI, inclusive 7 Empoasca Walsh

KYBOS GENUS

3. a. Basal pegs on plate comblike 4 butleri line
- b. Basal pegs on plate absent 5 trifasciata line

butleri line

4. a. Aedeagus with stout lateral processes grosata (DeLong
and Davidson)
- b. Aedeagus without stout lateral lobes gelbata (DeLong
and Davidson)

trifasciata line

5. a. Anal hooks long and slender jacinta (DeLong
and Davidson)
- b. Anal hooks short and broad obtusa (Walsh)

KYBOASCA GENUS

6. a. Style apex directed dorsally (lateral aspect) denticula (Gillette)
- b. Style apex directed ventrally (lateral aspect) pergandeji (Gillette)

EMPOASCA GENUS

7. a. Aedeagus with processes on shaft subgenus Solanasca
 solana (DeLong)
- b. Aedeagus without processes on shaft 8 subgenus Empoasca
8. a. Style apex directed straight or dorsally (lateral aspect) 15 fabaq line
- b. Style apex directed ventrally (lateral aspect) 9 erigeron line

erigeron line

9. a. Caudodorsal lobe on plate reduced or absent
(lateral aspect) 10 esuma species group
- b. Caudodorsal lobe on plate retained (lateral aspect) .. 14 cerea species group

esuma species group

- | | | |
|--|----|--|
| 10.a. Brachones cross at least once at or near midpoint (ventral aspect) | 11 | |
| b. Brachones cross only once near apical end or do not cross (ventral aspect) | 12 | |
| 11.a. Anal hooks long, slender | | <u>decurvata</u> Davidson and DeLong |
| b. Anal hooks broad, flat | | <u>curvata</u> Poos |
| 12.a. Sternal II apodeme triangular | | <u>alboneura</u> Gillette |
| b. Sternal II apodeme not triangular | 13 | |
| 13.a. Anal hooks long, slender | | <u>esuma</u> Goding |
| b. Anal hooks broad, flat | | <u>vergana</u> DeLong and Caldwell |

cerea species group

14. a. Anal hooks bifurcate bifurcata DeLong
 b. Anal hooks not bifurcate erigeron DeLong

fabae line

- 15.a. Anal hook long and slender 16
 b. Anal hook short and flat 17
- 16.a. Lobe present on posteroventral margin of pygofer recurvata DeLong
 b. Lobe absent on posteroventral margin of pygofer pallida Gillette
- 17.a. Brachones expanded apically fabae (Harris)
 b. Brachones slender and fingerlike apically sativae Poos

Genus Kybos Fieber

Kybos Fieber, 1866a: 508 (type-species: Kybos smaragdula (Fallen), which is a synonym of Cicada smaragdula Fallen)

Kybos grosata (DeLong and Davidson)

Figure 1.

Empoasca grosata DeLong and Davidson, 1936a

Empoasca (Kybos) grosata: DeLong and Knull, 1946a

Kybos grosata (DeLong and Davidson): Anufriev, 1978

Body length: 4.60 mm; crown length: 0.18 - 0.20 mm; crown production: 0.10 mm; interocular width: 0.52 - 0.58 mm; pronotal length: 0.54 - 0.56 mm; pronotal width: 1.10 - 1.14 mm.

Sternal II apodeme attains segment 4 1/4, with two triangular lobes, margins narrow to bluntly rounded apices. Tergal III apodeme attains segment 4 1/4, with two well-separated crescentic lobes. Brachone, in lateral aspect, extends to posterior margin of pygofer, slender, expanded near apex,

constricted at apex, with apical region a fingerlike process, apex triangular; in ventral aspect, with basal region convergent mesad, sharply divergent, then convergent to apical region, apical region slightly divergent and triangular. Anal hook bases connected, broad basally, with apical portion long, slender, curved ventrocephalad.

Pygofer posterior margin quadrate, with 8 - 10 short, slender setae on posterior margin. Plate, in lateral aspect, with caudodorsal lobe; A-group setae 6, long, thick, comblike; B-group setae >20, short, thin; C-group setae >20, long, thick, quadraserrate; D-group setae long, thin; basal pegs 3 short, thick setae. Style, in lateral aspect, short, may reach posterior margin of pygofer, broad basally, with body broad and bowed ventrad, dentifer slender and directed posterodorsad, apex sharply curved dorsad, tapered sharply to form narrow spine; in ventral aspect, convergent mesad, with body broad, many long, slender setae on outer margin, divergent near base of dentifer, dentifer slender, with 12 teeth evenly spaced on ventromedial surface, apex strongly curved laterad. Aedeagus, in ventral aspect, with pair of thick, apically hooked, lateral processes arising at base of shaft, shaft long, slender, atrium slender and bluntly rounded.

Material studied: 1 male //Cedar City Utah/ 8-13-29/ R.H. Beamer// Paratype//Empoasca grosata DeLong and Davidson /RHD// [Parasitized] (KU), 1 male //July // Manitou, Colo./ E.S. Tucker// Paratype/ Empoasca grosata DeLong and Davidson// (KU). Male holotype reported to be deposited in DeLong collection (OHSU).

K. grosata appears to be related to gelbata. These species have similar abdominal apodemes, brachones, anal hooks, pygofer shape, and B-, C-, and D-group plate setae. K. grosata is distinct in the combination of A-group and basal

peg setal arrangement, the broad style body, and the aedeagal processes.

Kybos gelbata (DeLong and Davidson)

Figure 2.

Empoasca gelbata DeLong and Davidson, 1936a

Empoasca (Kybos) gelbata: Medler, 1943a

Kybos gelbata (DeLong and Davidson): Anufriev, 1978

Body length: 3.68 - 4.04 mm; crown length: 0.17 - 0.20 mm; crown
production: 0.08 - 0.10 mm; interocular width: 0.46 - 0.48 mm; pronotal
length: 0.41 - 0.52 mm; pronotal width: 0.88 - 1.04 mm.

Sternal II apodeme attains segment 4 1/2 - 5 1/2 (length: 0.41 - 0.43 mm,
width: 0.37 - 0.42 mm), with margins parallel to broadly rounded apices. Sternal
IV apodeme a narrow transverse ridge (length: 0.036 - 0.045 mm). Tergal III
apodeme with two well separated crescentic lobes (length: 0.072 - 0.099 mm).
Brachone, in lateral aspect, extends to posterior margin of pygofer, slender,
expanded near apex, constricted at apex, with apical region a fingerlike process,
apex triangular; in ventral aspect, with basal region convergent mesad, sharply
divergent, then convergent to apical region, apical region slightly divergent and
triangular. Anal hook bases connected, broad basally, with apical portion long,
slender and curved ventrocephalad.

Pygofer posterior margin quadrate, with 8 - 10 short, slender setae on
posterior margin. Plate, in lateral aspect, with dorsocaudal lobe; A-group setae 4,
long, thick, comblike; B-group setae >20, short, thin; C-group setae >20, long,
thick, quadraserrate; D-group setae >20, long, thin; basal pegs four thick setae,
one short and three twice as long. Style, in lateral aspect, short, may reach

posterior pygofer margin, broad basally, with body slender and bowed ventrad, dentifer slender and bowed dorsad, apex sharply curved dorsad and tapered sharply to form narrow spine; in ventral aspect, convergent mesad, with body slender, many long, slender setae on outer margin, divergent near base of dentifer, dentifer with 9 teeth evenly spaced on ventromedial surface, apex strongly curved laterad. Aedeagus, in ventral aspect, with shaft narrow at base, slightly expanded then narrowed to gonopore, atrial area around gonopore expanded, atrium narrowed and bluntly rounded.

Material studied: 1 male //Douglas Co Ks/ 6-25-1926/ Trap Light/ P.B. Lawson// (KU), 1 male // Douglas Co Ks/ 6-25-1926/ Trap Light/ P.B. Lawson// [Misidentified as Empoasca copula DeLong] (KU), 1 male //Douglas Co Ks/ 6-26-1926/ Trap Light/ P.B. Lawson// [Misidentified as Empoasca grosata DeLong and Davidson] (KU), 1 male // Riley Co. Ks// D.A. Wilbur/ Coll// (KSU). Male holotype and female paratypes reported to be deposited in DeLong collection (OHSU). Female allotype and male and female paratypes reported to be deposited in Ball collection (USNM).

K. gelbata appears to be related to grosata. These species have similar abdominal apodemes, brachones, anal hooks, pygofer shape, and B-, C-, and D-group plate setae. K. gelbata is distinct in the combination of A-group and basal peg setal arrangement, slender style body, and absence of aedeagal processes.

Kybos jacinta (DeLong and Davidson)

Figure 3.

Empoasca jacinta DeLong and Davidson, 1936a

Empoasca (Kybos) jacinta: DeLong and Knull, 1946a

Kybos jacinta (DeLong and Davidson): Anufriev, 1978

Body length: 3.60 - 3.88 mm; crown length: 0.18 - 0.20 mm; crown
production: 0.07 - 0.08 mm; interocular width: 0.40 - 0.44 mm; pronotal
length: 0.40 - 0.50 mm; pronotal width: 0.82 - 0.88 mm.

Sternal II apodeme attains segment 7 - 7 7/8 (length: 0.59 - 0.72 mm;
width: 0.39 - 0.56 mm), with margins parallel to broadly rounded apices. Sternal
IV apodeme a narrow transverse ridge (length: 0.027 - 0.045 mm). Tergal III
apodeme attains segment 4 1/4 (length: 0.063 - 0.072, width: 0.45 - 0.54 mm),
with two widely separated crescentic lobes. Brachone, in lateral aspect, extends to
posterior margin of pygofer, slender, with mesal margin of apex a concave,
fingerlike process; in ventral aspect, slender, with entire process directed slightly
mesad, apical region curved slightly laterad, inner margin concave and apex pointed.
Anal hook bases connected, broad basally, with apical portion long, slender and
curved ventrocephalad.

Pygofer posterior margin quadrate, with 6 - 8 short, thin setae on posterior
margin. Plate, in lateral aspect, with dorsocaudal lobe; A-group setae 4 - 6, long,
thin; B-group setae > 20, short, thin; C-group setae > 20, long, thick,
quadraserrate; D-group setae 15 - 20, at least twice as long as A-group, thin;
basal pegs absent. Style, in lateral aspect, short, not reaching posterior margin of
pygofer, broad basally, bowed dorsad, with apex sharply directed dorsad; in ventral
aspect, with base of body divergent, body broad and convergent mesad, almost figure
eight in shape, constricted at midpoint then expanded again, many long slender setae

on ventral margin, dentifer distinct from body, long, narrow and curved laterad, 12 teeth on ventromedial surface, apex bluntly rounded. Aedeagus, in ventral aspect, with base of shaft slender, shaft expanded to atrium, atrium narrowed to apex.

Material studied: 1 male //Riley Co. Ks// 11-22-34/ D.A. Wilbur/ Coll.//
Sep 15// [Misidentified as Empoasca aureoviridis Uhler]. (KSU), 1 male
//Manhattan, Ks/ 11 July 1932//D.A. Wilbur/Coll.// (KSU), 1 male
//Manhattan, Ks/ 15 June 1932// D.A. Wilbur/ Coll.// (KSU), 1 male
//Goodland, Ks./ Aug. 13, 1931// D.A. Wilbur/ Coll.// (KSU), 2 males //Jul 11//
PJParrott/ Riley Co KS// (KSU). Male holotype, female allotype and male and female paratypes reported to be deposited in KU. Male and female paratypes reported to be deposited in the DeLong collection (OHSU).

K. jacinta appears to be related to obtusa. These species have similar sternal IV and tergal III abdominal apodemes, brachones, plate shape and setal patterns, and aedeagus. K. jacinta is distinct in the combination of longer sternal II apodemes, apically slender anal hooks, posterior margin of pygofer quadrate, and bluntly rounded style apex.

Kybos obtusa (Walsh)

Figure 4.

Empoasca obtusa Walsh, 1862a

Empoasca (Kybos) obtusa: DeLong, 1931b

Kybos obtusa (Walsh): Anufriev, 1978

Body length: 3.60 - 4.24 mm; crown length: 0.16 - 0.22 mm; crown
production: 0.07 - 0.10 mm; interocular width: 0.42 - 0.54 mm; pronotal
length: 0.42 - 0.54 mm; pronotal width: 0.92 - 1.13 mm.

Sternal II apodeme attains segment 5 - 7 (length: 0.38 - 0.52 mm, width: 0.41 - 0.58 mm), with margins parallel, apex outer margins shorter than inner margins, apex margin lipped. Sternal IV apodeme a narrow transverse ridge (length: 0.036 - 0.063 mm). Tergal III apodeme attains segment 4, with two widely separated crescentic lobes (length: 0.054 - 0.108 mm). Brachone, in lateral aspect, extends to posterior margin of pygofer, slender, with mesal margin of apex a concave, fingerlike process; in ventral aspect, slender, directed mesad, with apical region curved slightly laterad, inner margin concave and apex pointed. Anal hook bases connected, short and broad, broader basally, with apex portion short, broad and curved ventrocephalad.

Pygofer posterior margin concave, with 8 - 10 short, slender setae on posterior margin. Plate, in lateral aspect, with dorsocaudal lobe; A-group setae 4 - 6, long, thin; B-group setae >20, short, thin; C-group setae >20, long, thick, quadraserate; D-group setae 15 - 20, at least twice as long as A-group, thin; basal pegs absent. Style, in lateral aspect, short, not reaching posterior margin of pygofer, broad basally, bowed dorsad, with apex sharply directed dorsad; in ventral aspect, with base of body divergent, body broad and convergent mesad, almost figure eight in shape, constricted at midpoint then expanded again, many long slender setae on ventral margin, dentifer distinct from body, long, narrow and curved laterad, 12 teeth on ventromedial surface, dentifer sharply constricted at apex, apex a long and slender fingerlike process strongly curved laterad and pointed. Aedeagus, in ventral aspect, with base of shaft slender, shaft expanded to atrium, atrium narrowed to apex.

Material studied: 1 male //Douglas Co/ Kan// (KU), 1 male //Douglas Co Ks/ 7-10-1937/ trap light/ P.B. Lawson// [Kybos obtusa (Walsh)] (KU), 5 males

//Douglas Co, Ks/ 6-27-1930/ Trap light/ P.B.Lawson// (KU), 1 male //
 Douglas Co, Ks/ 6-24-1930/ Trap light/ P.B.Lawson// (KU), 1 male // Douglas
 Co, Ks/ 6-29-1930/ Trap light/ P.B.Lawson// (KU), 1 male // Douglas Co, Ks/
 7-9-1930/ Trap light/ P.B.Lawson// (KU), 4 males //Medora Kans/ 6-34-36/
 D.R. Lindsay// (KU), 1 male //Paul B. Lawson/ Ottawa Co. Ks// (KU), 1 male
 //Republic Co./ Ks 7.11.25/ H.O. Deay// (KU), 3 males //Doniphan Co/ Ks
 7-19-1924/ R.H. Beamer// (KU), 1 male //Clarksville/ 7-29-14 Tenn//
 (KU), 1 male //Pueblo, Col./ 6-25-37/ C.L. Johnston// (KU), 13 males //Fort
 Collins/ Colo. 7- 14-34// (KU), 3 males //Pueblo, Col./ 6-25-37/ C.L.
 Johnston// (KU), 3 males //Fort Collins/ Colo. 7- 14-34// Collector/
 K. Maehler// (KU), 4 males //Fort Collins, Colo./ 8-6-35/ K. Maehler// (KU),
 1 male //Allen Co Ks// (KU), 1 male //Douglas Co Ks/ 6-25-1930/ Trap light/
 P.B. Lawson// (KU), 1 male //Clarksville/ 7-29-14/ Tenn// (KU), 1 male //
 PJ Parrott/ Riley Co Ks// (KSU), 4 males //Sand dunes/ Medora, Ks// Jun 21//
 D.A. Wilbur/ Coll// (KSU), 1 male //Manhattan, Ks./ 14 July 1932// D.A.
 Wilbur/ Coll// (KSU), 3 males //Manhattan, Ks./ 11 July 1932// D.A. Wilbur/
 Coll// (KSU), 1 male //Manhattan, Ks./ 30 July 1932// D.A. Wilbur/ Coll//
 (KSU), 1 male //Jun 5// PJ Parrott/ Riley Co Ks// (KSU), 6 males //Riley Co.
 Ks// D.A. Wilbur/ Coll// (KSU). The type has been reported to have been
 destroyed in the Chicago fire. A neotype has been reported to be deposited in the
 DeLong collection (OHSU).

K. obtusa appears to be related to jacinta. These species have similar sternal
 IV and tergal III abdominal apodemes, brachones, plate shape and setal patterns,
 and aedeagus. K. obtusa is distinct in the combination of shorter sternal II

apodemes, apically broad anal hooks, posterior margin of pygofer concave, and long, fingerlike style apex.

Genus Kyboasca Zachvatkin

Kyboasca Zachvatkin, 1953: 228 (type-species: Kyboasca bipunctata (Oshanin), which is a synonym of Chlorita bipunctata Oshanin)

Kyboasca denticula (Gillette)

Figure 5.

Empoasca denticula Gillette, 1898a

Kyboasca denticula (Gillette): Anufriev, 1978

Body length: 3.24 mm; crown length: 0.18 mm; crown production: 0.05 mm; interocular width: 0.36 mm; pronotal length: 0.40 mm; pronotal width: 0.74 mm.

Sternal I apodeme complex: medial notch of dorsal apodeme attains heavily sclerotized sternal bar, basal one-half abruptly constricted, lateral apodeme thin, weakly sclerotized, directed anterolaterad band, curved posteromesad to sternal bar, a thin, weakly sclerotized Y-shaped band projects from anterior apex of this band at approximately one-fourth distance, joining dorsal apodeme and sternal bar, and directed posteromesad. No sternal apodemes present from segment II or greater. Tergal III apodeme a narrow transverse ridge. Tergal IV apodeme with two short (0.072 mm) crescentric lobes curved anteriorly. Tergal V apodeme like IV but shorter (0.054 mm). Tergal VI apodeme with two short (0.036 mm), crescentric, posteriorly directed lobes. Tergal VII apodeme like VI, but longer (0.054 mm). Brachone, in lateral aspect, curved evenly and moderately dorsad to apical one-fifth then sharply curved dorsad, gradually tapered to narrow, bluntly rounded apex, exceeding pygofer; in ventral aspect, convergent mesad to apical one-fifth, divergent and tapered to narrow, bluntly, rounded apex. Anal hook bases

not connected, short, with basal two-thirds broad and bowed posteriorly, narrowed on posteroventrad margin to form anteroventrad directed spine.

Pygofer tapered on ventral and dorsal margins to distinct apex (triangular), with 7 - 9 short, thick setae on posterodorsal margin. Plate, in lateral aspect, with dorsocaudal lobe; A-group setae 4-5, short, thin; B-group setae 11, similar to A-group; C-group setae 16 - 18, long, thick, biserrate; D-group setae 11 - 15, long, thin. Style, in lateral aspect, with body bowed ventrally and narrowed at dentifer, apex long and bluntly pointed, attains posterior margin of pygofer; in ventral aspect, convergent mesad then slightly divergent, with short setae on outer margin of body, dentifer with 15 - 17 small teeth on dorsolateral surface, apex rounded. Aedeagus, in ventral aspect, simple, with base of shaft slender, expanded to atrium, atrium slightly expanded from near shaft to near apex, apex rounded.

Material studied: one male //Douglas Co. Ks./7-30-1929/Trap Light/ P. B. Lawson// (KU). Cotype No. 3426 reported to be deposited in USNM.

K. denticula appears to be related to pergandei. These species have similar sternal I apodeme complexes and similar tergal III apodeme structures, unconnected anal hook bases, plate shape and setal patterns, and aedeagal structures. K. denticula is distinct in the combination of a wider and more dorsally bowed style, an undifferentiated brachone apex, a pointed anal hook apex, and smaller tergal IV - VII apodemes.

Kyboasca pergandei (Gillette)

Figure 6.

Empoasca pergandei Gillette, 1898a

Empoasca (Kyboasca) pergandei: Cunningham, 1962

Kyboasca pergandei (Gillette): Anufriev, 1978

Body length: 2.84 - 3.16 mm; crown length: 0.14 - 0.18 mm; crown
production: 0.04 - 0.05 mm; interocular width: 0.30 - 0.34 mm; pronotal
length: 0.32 - 0.44 mm; pronotal width: 0.68 - 0.78 mm.

Sternal I apodeme complex: medial notch of dorsal apodeme attains heavily
sclerotized sternal bar, basal one-half abruptly constricted, lateral apodeme a
thin, weakly sclerotized, directed anterolaterad band, curved posteromesad to
sternal bar, a thin, weakly sclerotized Y-shaped band projects from anterior apex
of this band at approximately one-fourth distance, joining dorsal apodeme and
sternal bar, and directed posteromesad. Sternal apodemes not present from segment
II or greater. Tergal III apodeme a narrow, transverse ridge. Tergal IV apodeme a
narrow transverse ridge. Tergal V apodeme with two short (0.036 - 0.072 mm)
crescentic lobes directed anteriorly. Tergal VI apodeme with two medial lobes
directed anteriorly (0.036 - 0.063 mm) and lateral margins directed posteriorly
0.09 mm. Tergal VII apodeme with two lobes (0.117 - 0.162 mm) directed
posteriorly. Brachone, in lateral aspect, with body slender, parallel margin,
narrowed at apex, apex a thin, fingerlike process that extends past pygofer; in
ventral aspect, convergent mesad to apical one-fifth, divergent and tapered to
narrow, fingerlike apices. Anal hook bases not connected, short, with basal
two-thirds broad and bowed posteriorly, broadly rounded on posteroventrad margin
to form blunt apex.

Pygofer tapered on ventral and dorsal margins to distinct apex (triangular), with 9 - 11 short setae on posterodorsal margin. Plate, in lateral aspect, with dorsocaudal lobe; A-group setae 4 - 6, short, thin; B-group setae 18 - 20, short, thin; C-group setae 16 - 18, long, thick, biserrate; D-group setae 11 - 15, long, thin. Style, in lateral aspect, straight to slightly bowed ventrally and narrowed at dentifer, apex long, bluntly pointed extends past posterior margin of pygofer; in ventral aspect, convergent mesad then slightly divergent, with short setae on outer margin, dentifer with 13 small teeth on ventromedial surface, apex rounded. Aedeagus, in ventral aspect, simple, with base of shaft slender, expanded to atrium, atrium slightly expanded from near shaft to near apex, apex rounded.

Material studied: 8 males //Conway Springs/ Ks. VII 6,1944/ R.H. Beamer/ blk.locust (KU), 1 male //Conway Springs/ Ks. VII 6,1944/ R.H. Beamer/ blk.locust// (KU), 4 males //Fayetteville, Ark/ 1938/ M.W.Sanderson (KU), 1 male// Fayetteville,Ark/1938/ M.W. Sanderson// (KU). Type No. 3427 reported to be deposited in USNM.

K. pergandei appears to be related to denticula. These species have similar sternal I apodeme complexes, similar tergal III apodeme structures, and unconnected anal hook bases. The plate shape and setal patterns, and aedeagal structures are also similar. K. pergandei is distinct in the combination of the narrower and straighter or more ventrally bowed style, the differentiated brachone apex, the blunt anal hook apex, and the larger tergal IV - VII apodemes.

Genus Empoasca Walsh

Empoasca Walsh, 1862: 149 (type-species: Empoasca viridescens Walsh, which is a synonym of Tettigonia fabae Harris)

Empoasca (Solanasca) solana DeLong, new status Figure 7.

Empoasca (Empoasca) solana DeLong, 1931b

Solanasca solana (DeLong): Ghauri, 1974

Body length: 3.00 - 3.10 mm; crown length: 0.18 - 0.20 mm; crown
production: 0.08 - 0.09 mm; interocular width: 0.33 - 0.36 mm; pronotal
length: 0.30 - 0.34 mm; pronotal width: 0.62 - 0.67 mm.

Sternal II apodeme attains segment 6 1/2 - 7 (length: 0.42 - 0.50 mm,
width: 0.34 - 0.36 mm), with lobes paddle-shaped, all margins parallel, inner
apical margin shorter than outer apical margin, basal inner margin shorter than
basal outer margin, apices divergent. Sternal IV apodeme a narrow transverse
ridge. Tergal III apodeme with two crescentic lobes (0.63 - 0.072 mm).
Brachones, in lateral aspect, extends past posterior margin of pygofer, slender,
tapered to distinct fingerlike apex; in ventral aspect, broad basally, convergent
mesad and produced forming pointed forceplike apices. Anal hook bases connected,
broad plates with apices bluntly rounded and directed ventrocephalad.

Pygofer posterior margin triangular, with 6 short setae. Plate, in lateral
aspect, with caudodorsal lobe; A-group setae 3, short, thin; B-group setae >20,
at least twice as short as A-group, thin; C-group setae >20, long, thick, triserrate;
D-group setae >20, long, thin; basal pegs absent. Style, in lateral aspect, short,
does not reach posterior margin of pygofer, broad basally, with body slender and
bowed ventrad, dentifer short and broad, apices directed dorsad; in ventral aspect,

with 3 short, thin setae on outer lateral margin of body, convergent mesad, body slender, dentifer with 6 - 7 teeth on ventromedial margin, divergent, and tapered to a sharp apex. Aedeagus, in lateral aspect, with a long, posterodorsally directed process from midpoint of shaft; in ventral aspect, with base slender, shaft slightly wider than base, processes lay close to ventral edge of shaft, atrial area around gonopore expanded, atrium narrowed and apex concave.

Material studied: 1 male //Douglas Co./ Kans. X.5.1931/ R.H. Beamer// (KU), 1 male //Kinsley Kans./ 7-17-44/ (KU), 1 male //Fayetteville Ark./ 10-2-1937/ M.W. Sanderson// (KU), 1 male //Patagonia Ariz./ August 21, 1935/ R.H. Beamer// [Parasitized by pipunculid] (KU), 1 male //Patagonia Ariz./ August 21, 1935/ R.H. Beamer// (KU). Holotype male reported to be deposited in USNM. Paratype male reported to be deposited in the DeLong collection (OHSU).

E. solana is the only species of Solanasca found in Kansas. E. (S.) solana is distinct from species of the subgenus Empoasca in the presence of ventral aedeagal processes.

Empoasca (Empoasca) decurvata Davidson and DeLong
Figure 8.

Empoasca decurvata Davidson and DeLong, 1938a

Empoasca (Empoasca) decurvata: DeLong and Knull, 1946a

Body length: 3.32 mm; crown length: 0.21 - 0.22 mm; crown production: 0.12 mm; interocular width: 0.34 - 0.36 mm; pronotal length: 0.37 mm; pronotal width: 0.72 mm.

Sternal II apodeme attains segment 4, with lateral margins parallel, apex bluntly rounded. No tergal apodemes present. Brachone, in lateral aspect, extends past posterior margin of pygofer, slender, biangulate, directed posteriorly then

sharply directed dorsad then directed posteroventrad, with apex bluntly rounded; in ventral aspect, broad basally, with slender body, curved sharply mesad, crosses adjacent brachone near midpoint, slightly curved ventrolaterad, convergent and forms bluntly rounded, forceplike apex, or may cross other brachone near apex and diverge to bluntly rounded apex. Anal hook bases connected, broad basally, with apical portion long and tapered gradually to bluntly rounded apex, directed ventrocephalad.

Pygofer posterior margin broadly rounded. Setal pattern on pygofer unknown. Plate, in lateral aspect, with caudodorsal lobe absent; A-group setae 3 - 5, short, thin; B-group setae >20, at least twice as short as A-group, thin; C-group >20, long, thick, biserrate; D-group >20, long, thin; no basal pegs. Style, in lateral aspect, may extend to posterior end of pygofer, broad basally, with body slender and bowed slightly ventrad, dentifer directed ventrad, with apex bluntly rounded; in ventral aspect, convergent mesad, body slender, with 3 - 4 short, thin setae on outer lateral margin, divergent near base of dentifer; dentifer with 6 - 7 small teeth on ventromedial margin, tapered to bluntly rounded apex. Aedeagus, in ventral aspect, with shaft slender, atrial area around gonopore expanded, atrium narrowed and bluntly rounded.

Material studied: Holotype 1 male // Empoasca decurvata // Clarksville, Tenn/ 7-14-17/ 115// Holotype// (OHSU), 1 male //P.B. Lawson/K 7-9-1924/ Douglas Co// Paratype// (KU).

E. decurvata appears to be related to curvata. These species have similar abdominal apodemes, brachones, connected anal hook bases, pygofers, plates, styles, and aedeagus. E. decurvata has a distinct long and slender anal hook.

Empoasca (Empoasca) curvata Poos

Figure 9.

Empoasca curvata Poos, 1933a

Empoasca (Empoasca) curvata: Medler, 1943a

Body length: 2.64 mm; crown length: 0.21 - 0.27 mm; crown production: 0.09 mm; interocular width: 0.30 - 0.33 mm; pronotal length: 0.30 - 0.36 mm; pronotal width: 0.56 - 0.69 mm.

Sternal II apodeme attains segment 4, with lateral margins parallel, apex bluntly rounded. No tergal apodemes present. Brachone, in lateral aspect, extends past posterior margin of pygofer, slender, biangulate, directed posteriorly then sharply directed dorsad then directed posteroventrad, with apex bluntly rounded; in ventral aspect, broad basally, with slender body, curved sharply mesad, crosses adjacent brachone near midpoint, slightly curved ventrolaterad, convergent and forms bluntly rounded forceplike apex with adjacent brachone, or may cross adjacent brachone near apex and diverge to bluntly rounded apex. Anal hook bases connected, broad, flat plate, rounded on posterior margin, with spine-shaped apex directed ventrad or ventrocephalad.

Pygofer posterior margin broadly rounded or quadrate, with setal pattern unknown. Plate, in lateral aspect, with caudodorsal lobe absent, setal pattern unknown. Style, in lateral aspect, may extend to posterior end of pygofer, broad basally, with slender, slightly ventrally bowed body, dentifer directed ventrad, with apex bluntly rounded; in ventral aspect, convergent mesad, with slender body, divergent near base of dentifer, tapered to bluntly rounded apex. Aedeagus, in ventral aspect, with shaft slender, atrial area around gonopore expanded, atrium narrowed and bluntly rounded.

Material studied: Holotype 1 male //Arlington/ Va 3-25-32// J.W.
Scrivener/ Coll// Collected on/ honeysuckle/ in field (Cage 321)// Type No./
49936/ USNM// Empoasca curvata Poos// (USNM), 1 male //Manhattan,/
Kansas/ VIII - 1945// N.L.H. Krauss// Compared/ with type ISC// Homotype/
Empoasca curvata Poos// (KU).

E. curvata appears to be related to decurvata. These species have similar abdominal apodemes, brachones, connected anal hook bases, pygofer, plates, styles, and aedeagus. E. curvata has a distinct broad, flat anal hook.

Empoasca (Empoasca) alboneura Gillette
Figure 10.

Empoasca alboneura Gillette, 1898a
Empoasca (Empoasca) alboneura: Cunningham, 1962

Body length: 2.58 -2.99 mm; crown length: 0.15 -0.20 mm; crown
production: 0.08 - 0.13 mm; interocular width: 0.30 - 0.40 mm; pronotal
length: 0.31 - 0.38 mm; pronotal width: 0.62 - 0.70 mm.

Sternal II apodeme attains segment 4 - 4 1/2 (length: 0.11 - 0.14 mm;
width: 0.22 - 0.27 mm), with lateral margins narrow to bluntly rounded posterior
ends, triangular-shaped. No other abdominal apodemes present. Brachone, in
lateral aspect, extends past posterior margin of pygofer, slender, expanded near
apex, with apical region concave dorsad, apex a distinct fingerlike process;
in ventral aspect, broad basally, convergent mesad to apical region, with apical
region divergent and expanded, apex a narrow, distinct fingerlike process. Anal
hook bases connected, broad basally, with apical portion tapered gradually to

bluntly rounded, sickleshaped apex, and curved ventrocephalad.

Pygofer posterior margin broadly rounded or with a distinct, somewhat triangular apex, with 4 - 6 short, slender setae. Plate, in lateral aspect, with caudodorsal lobe absent; A-group setae 3- 5, short, thin; B-group setae >20, short, thin; C-group setae 12 - 14, long, thick, biserrate; D-group setae 12 - 14, long, thin; no basal pegs. Style, in lateral aspect, long, attains or exceeds posterior margin of pygofer, broad basally, with body broad and bowed slightly ventrad, with distinct, mesally directed hook from outer lateral margin; in ventral aspect, with dentifer bowed weakly dorsad to ventrally recurved apex, convergent mesad, body slender, no setae present, divergent near base of dentifer, dentifer with 6 teeth on ventromedial surface, tapered to bluntly rounded apex with a laterally directed hooklike process. Aedeagus, in ventral aspect, with shaft slender, atrial area around gonopore expanded, atrium narrowed and bluntly rounded.

Material studied: 1 male //Colo 2781// Type// (KU), 2 males //Ft. Collins, Colo./ 8-18-29// D.A. Wilbur/ Coll.// (KSU), 1 male //Manhattan, Ks/ Oct. 20-28// D.A. Wilbur/ Coll.// (KSU), 1 male //Sand dunes/ Medora, Kans.// July 4// D.A. Wilbur/ Coll. 1930// (KSU). Type reported to be deposited in USNM.

E. alboneura appears to be related to gsuma and vergena. These species have similar brachones that cross near the apex or not and basally connected anal hooks. The posterior margin of the pygofer is broadly rounded or with a distinct, somewhat triangular apex. The plates have no basal pegs and the caudodorsal lobe is reduced or absent. The styles have few or no setae on the outer lateral margin and the apices are directed ventrally. The aedeagus has a slender shaft and the atrial area is expanded around the gonopore. E. alboneura is distinct in the triangular sternal II apodemes. The brachone apex has a narrow, distinct fingerlike process, and the anal

hook is sickle-shaped. There is a long style that attains or extends past the posterior pygofer margin and has a hooklike apex. The aedeagus apex is narrowed and bluntly rounded.

Empoasca (Empoasca) esuma Goding

Figure 11.

Empoasca esuma Goding, 1890b

Empoasca (Empoasca) esuma: Oman, 1949a

Body length: 3.16 - 3.88 mm; crown length: 0.20 - 0.28 mm; crown production: 0.10 - 0.14 mm; interocular width: 0.36 - 0.40 mm; pronotal length: 0.32 - 0.46 mm; pronotal width: 0.60 - 0.84 mm.

Sternal II apodeme attains segment 5 (length: 0.23 - 0.27 mm, width: 0.31 mm), with margins parallel, tapered slightly to obliquely truncate apex.

Brachone, in lateral aspect, does not reach posterior margin of pygofer, slender, tapered to sharp apex, with apex strongly curved dorsad; in ventral aspect, broad basally, with slender body, convergent mesad, tapered to a sharp apex. Anal hook bases connected, broad basally, with apical portion long, slender and curved ventrocephalad.

Pygofer posterior margin broadly rounded or with a distinct, somewhat triangular apex, with many long, slender setae. Plate, in lateral aspect, with caudodorsal lobe reduced; A-group setae 4 - 6, short, thin; B-group setae 18 - 20, short, thin; C-group setae 16 - 18, long, thick, biserrate; D-group setae 16 - 18, long, thin; no basal pegs. Style, in lateral aspect, short, does not reach posterior margin of pygofer, with body bowed ventrad, dentifer bowed strongly dorsad; in ventral aspect, convergent mesad, with slender body, 4 short, thin setae on outer lateral margin of body, dentifer with 8 - 9 teeth on ventromedial

margin, apical region divergent and tapered to blunt apex. Aedeagus, in ventral aspect, with shaft slender, atrial area expanded, atrium apex concave.

Material studied: 1 male //Douglas Co Ks/ 7-28-1930/ Trap light/ P.B.

Lawson// 193// (KU), 3 males //Strawberry la/ 4-18-34/ R.H. Beamer//

(KU). Location of type unknown to author.

E. esuma appears to be related to vergena and alboneura. These species have similar brachones that cross near the apex or not and basally connected anal hooks. The posterior margin of the pygofer is broadly rounded or with a distinct, somewhat triangular apex. The plates have no basal pegs and the caudodorsal lobe is reduced or absent. The styles have few or no setae on the outer lateral margin and the apices are directed ventrally. The aedeagus has a slender shaft and the atrial area is expanded around the gonopore. E. esuma and vergena appear to differ from alboneura in the presence of sternal II apodemes that are not triangular. The brachone apex is not a narrow, distinct fingerlike process, and the anal hooks are not sickleshaped. The short styles do not reach the posterior margin of the pygofer, and the apex of the aedeagus is concave. E. esuma is distinct in the combination of sternal II apodeme margins which are parallel and tapered slightly to an obliquely truncate apex. The apex of the brachone is strongly curved dorsad, tapered to a sharp apex, and has a long, slender anal hook.

Empoasca (Empoasca) vergena DeLong and Caldwell

Figure 12.

Empoasca (Empoasca) vergena DeLong and Caldwell, 1934a

Body length: 3.16 - 3.52 mm; crown length: 0.18 - 0.24 mm; crown
production: 0.10 - 0.14 mm; interocular width: 0.36 - 0.42 mm; pronotal

length: 0.34 - 0.42 mm; pronotal width: 0.68 - 0.78 mm.

Sternal II apodeme attains segment 3 1/2 - 5 (length: 0.20 - 0.31 mm, width: 0.27 - 0.32 mm), with subparallel margins extending to broadly rounded or quadrate apices. No other apodemes present. Brachone, in lateral aspect, extends to posterior margin of pygofer, slender, gently tapered to sharp and slightly dorsally curved apex; in ventral aspect, broad basad, with body slender, basal two-thirds convergent mesad, apical one-third divergent then convergent and produced forming pointed, forceplike apices with adjacent brachone, which may cross adjacent brachone at apex. Anal hook bases connected, broad, flat plate, rounded on posterior margin, spine-shaped apex directed ventrad or ventrocephalad.

Pygofer posterior margin broadly rounded or with a distinct, somewhat triangular apex, with 6 - 7 short, slender setae. Plate, in lateral aspect, with caudodorsal lobe reduced; A-group setae 4, short, thin; B-group setae >20, short, thin; C-group setae 16 - 18, long, thick, biserrate; D-group setae 16 - 18, long, thin; no basal pegs. Style, in lateral aspect, short, does not reach posterior margin of pygofer, with body bowed ventrad, dentifer bowed strongly dorsad; in ventral aspect, convergent mesad, body slender, 4 short, thin setae on outer lateral margin of body, dentifer with 6 teeth on ventromedial surface, apical region divergent and tapered to blunt apex. Aedeagus, in ventral aspect, with shaft slender, atrial area expanded, atrium apex concave.

Material studied: 1 male //D.A. Wilbur/ Coll// Riley Co. Ks/ 3-23-30// [Misidentified as Empoasca birdii Goding] (KSU), 3 males //Riley Co. Ks./ 3-23-30// D.A. Wilbur/ Coll// (KSU), 2 males //Manhattan/ Ks./ 1929 June 14// D.A. Wilbur/ Coll// (KSU), 1 male //Manhattan/ Ks./ 1929 June 14// D.A. Wilbur/ Coll// (KSU), 1 male //Douglas Co. Ks./ 11-18-1944/ R.H. Beamer//

(KU), 8 males // Douglas Co. Ks./ 11-18-1944/ R.H. Beamer// (KU), 1 male //Washington/ Co. Ks. '24/ R.H. Beamer// (KU), 1 male //W.J. Brown/ Douglas Co./ Kansas/ 1-27-1922// (KU), 1 male //Douglas Co. Ks/ April 1924/ Wm. Robinson// 114// (KU), 1 male //Douglas Co. Kans/ 5.1.1928/ Trap Light/ P.B. Lawson// (KU), 1 male //Pottawatomie/ Co. Ks. 7.13.25/ H.O. Deny// (KU), 1 male //W.J. Brown/ Douglas Co./ Kansas/ 1-27-1922// [Misidentified as Empoasca birdii Goding] (KU), 1 male //P.B. Lawson/ Ks. 4.14.1924/ Douglas Co// (KU), 32 males //Douglas Co. Ks/ 11-18-1944/ R.H. Beamer// (KU). Holotype male and paratypes reported to be deposited in the DeLong collection (OHSU). Paratypes reported to be deposited in Illinois Natural History Survey collection.

E. vergena appears to be related to esuma and alboneura. These species have similar brachones that cross near the apex or not and basally connected anal hooks. The posterior margin of the pygofer is broadly rounded or with a distinct, somewhat triangular apex. The plates have no basal pegs and the caudodorsal lobe is reduced or absent. The styles have few or no setae on the outer lateral margin and the apices are directed ventrally. The aedeagus has a slender shaft and the atrial area is expanded around the gonopore. E. vergena and esuma appear to differ from alboneura in the presence of sternal II apodemes that are not triangular; the brachone apex is not a narrow, distinct fingerlike process, and the anal hooks are not sickleshaped. The short styles do not reach the posterior margin of the pygofer, and the aedeagus apex is concave. E. vergena is distinct in the combination of sternal II apodeme subparallel margins that extend to a broadly rounded or quadrate apex and brachone apices that are only slightly curved dorsad to produce pointed forceplike apices. The anal hook is broad and flat.

Empoasca (Empoasca) bifurcata DeLong
Figure 13.

Empoasca (Empoasca) bifurcata DeLong, 1931b

Body length: 2.64 - 3.30 mm; crown length: 0.18 - 0.26 mm; crown production: 0.10 - 0.13 mm; interocular width: 0.30 - 0.35 mm; pronotal length: 0.30 - 0.40 mm; pronotal width: 0.60 - 0.76 mm.

Sternal II apodeme reaching 5 - 6 1/4 (length: 0.27 - 0.37 mm, width: 0.27 - 0.33 mm), with margins subparallel to broadly rounded or quadrate apices. Sternal IV apodeme a narrow transverse ridge. No tergal apodemes present. Brachone, in lateral aspect, extends well past pygofer, slender, biangulate, directed posteriorly then sharply directed dorsad then directed posteroventrad, expanded near apex, narrowed to form a sharp apex; in ventral aspect, broad basally, with slender body, curved sharply mesad, crosses adjacent brachone near midpoint, slightly curved ventrolaterad, expanded near apex, convergent and produced forming pointed forceplike apex, or may cross adjacent brachone near apex and diverge to bluntly rounded apex. Anal hook bases connected, bifurcate, broad basally and directed slightly ventrocephalad with pair of long, slender divergent processes.

Pygofer posterior margin broadly rounded or quadrate, with 4 - 6 short, thin setae. Plate, in lateral aspect, with caudodorsal lobe, apical third directed sharply dorsad; A-group setae 4 - 6, short, thin; B-group setae >20, at least twice as short as A-group, thin; C-group setae >20, long, thick, biserrate; D-group setae >20, long, thin; no basal pegs. Style, in lateral aspect, short, does not reach posterior margin of pygofer, broad basally, with slender, ventrally bowed body, dentifer short and directed ventrad, apex bluntly rounded; in ventral aspect,

convergent mesad, body slender, 3 - 4 short, thin setae on outer lateral margin of body, divergent near base of dentifer, dentifer narrowed, with 4 - 5 small teeth on ventromedial margin, and tapered to blunt apex. Aedeagus, in ventral aspect, with shaft slender, atrial area around gonopore expanded, atrium narrowed and bluntly rounded.

Material studied: 4 males //Barberton, Ohio/ 8-11-36/ L.J. Lipovsky// (KU), 5 males //Barberton, Ohio/ 8-13-36/ L.J. Lipovsky// (KU), 1 male //Barberton, Ohio/ 7-23-36/ L.J. Lipovsky// (KU), 1 male //Barberton, Ohio/ 7-23-36/ L.J. Lipovsky// (KU), 3 males //Luxemburg Wis/ Aug 10 - 16, 34/ Paul B. Lawson// (KU), 1 male //New Haven/ Conn 8-20-34/ R.H. Beamer// (KU), 1 male //Ithaca, New York/ July 1921/ Paul B. Lawson// (KU), 1 male //East Troy, Wis/ Aug 10, 1935/ Paul B. Lawson// (KU), 1 male //Gratiot Ca/ Mich. 9-16-50/ R.R. Dreisbach// (KU), 1 male //Lacoochee, Fla/ 8-18-30/ P.W. Oman// (KU), 1 male // Polk Co. Ark/ 8-21-28/ R.H. Beamer// (KU).

Holotype male, allotype female, and paratype male and female reported to be deposited in Sanders and DeLong Collection (OHSU). Paratypes reported to be deposited in USNM, the Canadian National collection, and the collections of Herbert Osborn (OHSU) and E.D. Ball (USNM).

E. bifurcata appears to be related to erigeron. These species have similar sternal II and IV apodemes, absent tergal apodemes, connected anal hook bases, pygofers, caudodorsal lobes on the plates, absent basal pegs, and aedeagus.

E. bifurcata is distinct in the combination of brachones that cross at least once near the midpoint and styles with bluntly rounded apices.

Empoasca (Empoasca) erigeron DeLong

Figure 14.

Empoasca (Empoasca) erigeron DeLong, 1931b

Body length: 2.44 - 3.62 mm; crown length: 0.16 - 0.24 mm; crown production: 0.08 - 0.12 mm; interocular width: 0.28 - 0.38 mm; pronotal length: 0.28 - 0.42 mm; pronotal width: 0.56 - 0.76 mm.

Sternal II apodeme attains segment 4 1/2 - 6 (length: 0.22 - 0.29 mm, width: 0.23 - 0.32 mm), with margins subparallel to broadly rounded or quadrate apices. Sternal IV apodeme a narrow transverse ridge. No tergal apodemes present. Brachone, in lateral aspect, extends past posterior margin of pygofer, slender, with apical region expanded, apex a fingerlike process from dorsal margin of apical region; in ventral aspect, broad basally, body slender and convergent, apical region expanded with a fingerlike apex on outer lateral margin. Anal hook bases connected, broad basally, gradually tapered to blunt apex, directed ventrocephalad.

Pygofer posterior margin broadly rounded to quadrate, with 6 - 8 short, thin setae. Plate, in lateral aspect, with caudodorsal lobe; A-group setae 4 - 6, short, thin; B-group setae 16 - 20, at least twice as short as A-group, thin; C-group setae 12 - 14, long, thick, biserrate; D-group setae 16 - 18, long, thin; no basal pegs. Style, in lateral aspect, short, does not reach posterior margin of pygofer, broad basally, with slender, slightly ventrally bowed body, dentifer short and directed ventrad, apex sharply pointed; in ventral aspect, convergent mesad, body slender, with 4 - 5 short, thin setae on outer lateral margin of body, divergent near base of dentifer, dentifer with 6 small teeth on ventromedial surface, tapered to sharply pointed apex. Aedeagus, in ventral aspect, with shaft slender, atrial area

around gonopore expanded, atrium narrowed and bluntly rounded.

Material studied: 2 males //Barberton, Ohio/ 8-11-36/ L.J. Lipovsky//
(KU), 1 male //Norman Co. Minn./ Sept. 5, 1922/ A.A. Nichol// (KU), 5 males
//Wakulla Sprs/ Fla 7-14-34/ R.H. Beamer// (KU), 1 male //Wakulla Sprs/ Fla
7-14-34/ R.H. Beamer// (KU), 1 male //East Troy, Wis/ 8-10-35/ P.B.
Lawson// (KU), 1 male //East Troy, Wis/ Aug. 10, 35/ P.B. Lawson// (KU),
1 male //Garry [sic] Indiana/ 6-24-34/ M.W. Sanderson// (KU), 1 male
//Miami Co./ Kans. 1915/ R.H. Beamer// (KU), 1 male //Meridan, Miss./
7-17-30/ R.H. Beamer// (KU), 1 male //Bretton Woods/ N.H. 8-31-34/ R.H.
Beamer// (KU), 1 male //Tex. City Tex./ 11.2.1932/ L.D. Tuthill// (KU), 1 male
//Tex. City Tex./ 11.2.1932/ L.D. Tuthill// (KU), 1 male //Tallahassee Fla/
7-14-34/ R.H. Beamer// (KU), 1 male //Cedar River/ Mich. 8-26-37/ R.H.
Beamer// (KU), 1 male //Prattsburg Ga./ 7-25-30/ R.H. Beamer// 60// (KU),
1 male //5-10// F. Rogers/ K.C. Mo// (KU), 1 male // Prattsburg Ga./
7-25-30/ R.H. Beamer// (KU), 1 male //Fayetteville, Ark/ 1938/ M.W.
Sanderson// (KU), 1 male //Shuqualak Miss/ 7-16-30/ Paul W. Oman// 67//
(KU), 1 male // Ft. Mead Fla./ 8-13-30/ J. Nottingham// (KU), 1 male //Concan
Tex/ 7-6-36/ D.R. Lindsay// (KU), 1 male // Tallulah La/ 8-15-29/ J.G.
Shaw// (KU), 1 male //Galveston Tex./ 11.2.1932/ L.D. Tuthill// (KU), 1 male
//Kingman, Ks./ 9-1-30// Collected on/ Grasses// F.W. Poos/ Collector// (KU),
1 male //Douglas Co./ Ks 6-20-1930/ Trap light/ P.B. Lawson// (KU), 2 males
//Douglas Co./ Ks 6-26-1930/ Trap light/ P.B. Lawson// (KU), 1 male
//Douglas Co./ Ks 6-30-1930/ Trap light/ P.B. Lawson// (KU), 1 male
//Douglas Co./ Ks 7-10-1930/ Trap light/ P.B. Lawson// (KU), 1 male
//Douglas Co./ Ks 7-14-1930/ Trap light/ P.B. Lawson// (KU), 1 male

//Douglas Co./ Ks 7-22-1930/ Trap light/ P.B. Lawson// (KU), 1 male
 //Ellsworth Co/ Ks 7-12-23/ C.H. Martin// (KU), 1 male //Brownsville/ Tex
 6-29-38/ R.H. Beamer// (KU), 2 males //Bourbon Co KAS/ 5-30-35/ R.H.
 Beamer// (KU), 1 male //Sanford Fla/ 6-26-33/ C.O. Bare// (KU), 1 male
 //Batesburg S.C./ 8-24-30/ R.H. Beamer// (KU). Holotype male, allotype
 female, and paratypes reported to be deposited in DeLong collection (OHSU).
 Paratypes reported to be deposited in USNM and in the collection of E. D. Ball
 (USNM).

E. erigeron appears to be related to bifurcata. These species have similar
 sternal II and IV apodemes, absent tergal apodemes, connected anal hook bases,
 pygofer, caudodorsal lobes on the plates, absent basal pegs, and aedeagus.
E. erigeron is distinct in the combination of brachones with apical processes that do
 not cross and styles with sharply pointed apices.

Empoasca (Empoasca) recurvata DeLong
 Figure 15.

Empoasca (Empoasca) recurvata DeLong, 1931b

Body length: 2.56 - 2.76 mm; crown length: 0.18 - 0.20 mm; crown
 production: 0.10 - 0.11 mm; interocular width: 0.30 mm; pronotal length: 0.29
 - 0.32 mm; pronotal width: 0.57 - 0.58 mm.

Sternal II apodeme attains segment 4 (length: 0.09 mm, width: 0.18 - 0.23
 mm), with slender lobes widely separated at base and directed mesad. Sternal IV
 apodeme a narrow transverse ridge. Tergal III apodeme with small (length: 0.02 -
 0.03mm, width: 0.28 - 0.36 mm), widely separated crescentic lobes. Brachone,
 in lateral aspect, does not reach posterior margin of pygofer, slender, gently

tapered to sharp, dorsally curved apex; in ventral aspect, broad basad, with slender body, convergent mesad, tapered to a sharp, divergent apex. Anal hook bases connected, broad basally, with apical portion long, slender and curved ventrocephalad.

Pygofer posterior margin with a lobe present on posteroventral margin, with 6 - 8 short, thin setae on posterodorsal margin. Plate, in lateral aspect, with caudodorsal lobe; A-group setae 3, short, thin; B-group setae >20, at least twice as short as A-group, thin; C-group setae 15 - 18, long, thick, biserrate; D-group setae 18 - 20, long, thin; no basal pegs. Style, in lateral aspect, short, does not reach posterior margin of pygofer, with body bowed ventrad, dentifer bowed strongly dorsad, apex directed straight or dorsally; in ventral aspect, convergent mesad, body slender, with 3 short, thin setae on outer lateral margin, dentifer with 6 teeth on ventromedial surface, apical region divergent and tapered to sharp apex. Aedeagus, in ventral aspect, with shaft slender, atrial area around gonopore expanded, atrium narrowed and bluntly rounded.

Material studied: 1 male //Douglas Co Kans/ 5.10.1928/ Trap light/ P.B. Lawson// (KU), 1 male //Collected on /potato as/nymph//Charleston/ S. Car. 5-4-35// FW Poos/ Collector// (KU), 1 male //Douglas Co. Ks./ August 1923/ W. Robinson// (KU), 1 male //Reared on/ cowpea// Arlington/ Va 9-21-32// (KU), 1 male //Douglas Co Ks/ 7-2-1929/ Trap light/ P.B. Lawson// (KU), 1 male //Reared on/ cowpea// Arlington/ Va 8-18-32// (KU). Holotype male and paratype male reported to be deposited in the DeLong collection (OHSU).

E. recurvata appears to be related to *pallida*. These species have similar narrow, transverse sternal IV apodemes, anal hooks, caudodorsal lobe on plate, basal pegs absent, straight or dorsally directed style apex, and similar aedeagus

structures. E. recurvata is distinct in the combination of shorter sternal II apodemes, laterally thinner tergal III apodemes, short and dorsally directed brachones. It has a lobe present on the posteroventral margin of the pygofer.

Empoasca (Empoasca) pallida Gillette
Figure 16.

Empoasca pallida Gillette, 1898a

Empoasca (Empoasca) pallida: Medler, 1943a

Body length: 3.04 - 3.92 mm; crown length: 0.22 - 0.26 mm; crown production: 0.10 - 0.12 mm; interocular width: 0.34 - 0.40 mm; pronotal length: 0.38 - 0.44 mm; pronotal width: 0.70 - 0.84 mm.

Sternal II apodeme attains segment 5 $\frac{3}{4}$ - 6 (length: 0.39 - 0.49 mm, width: 0.36 - 0.54 mm), with margins subparallel to broadly rounded or quadrate apices. Sternal IV apodeme a narrow transverse ridge. Tergal III apodeme thick, extends from lateral margin mesad to two small, widely separated crescentic lobes (length: 0.03 - 0.45 mm, width: 0.35 - 0.40 mm). Brachone, in lateral aspect, extends past posterior margin of pygofer, slender, tapered to sharp apex; in ventral aspect, broad basally, body slender, convergent mesad, tapered to a sharp apex, may cross with other brachone apically. Anal hook bases connected, broad basally, with apical portion long, slender and curved ventrocephalad.

Pygofer posterior margin broadly rounded or with a distinct, somewhat triangular apex, with 6 - 8 short, thin setae. Plate, in lateral aspect, with caudodorsal lobe; A-group setae 6 - 8, short, thin; B-group setae >20, at least half as short as A-group, thin; C-group setae >20, long, thick, triserrate; D-group setae >20, long, thin; basal pegs not present. Style, in lateral aspect, long, attains

posterior margin of pygofer, with body bowed slightly ventrad, dentifer curved weakly ventrad to recurved, dorsally directed apex; in ventral aspect, convergent mesad, body slender, with 4 short, thin setae on outer lateral margin, dentifer with 6 - 7 teeth on ventromedial margin, apical region divergent and tapered to sharp apex. Aedeagus, in ventral aspect, with shaft slender, long, atrial area expanded, atrium narrowed and bluntly rounded.

Material studied: 2 males //Oct// Riley Co Ks/ Marlatt// Paratype//
[Identified as Empoasca constricta DeLong and Davidson] (KU), 1 male //Branford Fla./ 7-31-30/ R.H. Beamer// Paratype// [Identified as Empoasca constricta DeLong and Davidson] (KU), 1 male //Branford Fla./ 7-31-30/ R.H. Beamer// Paratype// [Identified as Empoasca constricta DeLong and Davidson] (KU), 1 male //Santa Rita Mts/ Ariz 7-19-38/ L.W. Hepner// (KU), 1 male //Santa Rita Mts/ Ariz 7-19-38/ L.W. Hepner// (KU), 1 male //Santa Rita Mts/ Ariz 7-22-38/ L.W. Hepner// (KU), 1 male //Bursville Ala./ 7-20-30/ L.D. Tuthill// (KU).
Type No. 3435 has been reported to be deposited in the USNM.

E. pallida appears to be related to recurvata. These species have similar narrow, transverse sternal IV apodemes, anal hooks, a caudodorsal lobe on the plate, no basal pegs, straight or dorsally directed style apices, and similar aedeagus structures. E. pallida is distinct in the combination of longer sternal II apodemes, laterally wider tergal III apodemes, long and straight brachones. The posterior margin of the pygofer is broadly rounded or somewhat triangular.

Empoasca (Empoasca) fabae (Harris)

Figure 17.

Tettigonia fabae Harris, 1841a

Empoasca fabae: Van Duzee, 1893b

Empoasca (Empoasca) fabae: DeLong, 1931b

Body length: 2.96 - 3.32 mm; crown length: 0.18 - 0.25 mm; crown production: 0.08 - 0.25 mm; interocular width: 0.31 - 0.36 mm; pronotal length: 0.28 - 0.36 mm; pronotal width: 0.66 - 0.76 mm.

Sternal II apodeme attains segment 3 1/2 - 4 1/4 (length: 0.14 - 0.19 mm, width: 0.23 - 0.29 mm), with short, narrow, lobes widely separated at base and directed mesad. Sternal IV apodeme a narrow transverse ridge (0.018 - 0.036 mm). Tergal III apodeme a narrow transverse ridge. Brachone, in lateral aspect, extends to or past posterior margin of pygofer, slender, with apical half expanded dorsad, apical fourth narrow, apex sharply pointed; in ventral aspect, basal region convergent mesad, expanded near midpoint, inner mesal margin concave, apical region slender and convergent, apex bluntly rounded and may cross adjacent brachone. Anal hook bases connected, with a broad, flat plate, rounded on posterior margin, short, spine-shaped apex directed ventrad or ventrocephalad.

Pygofer posterior margin triangular, with 10 short, thin setae. Plate, in lateral aspect, with caudodorsal lobe; A-group setae 3, short, thin; B-group setae >20, short, thin; C-group setae >20, long, thick, triserrate; D-group setae >20, long, thin; no basal pegs. Style, in lateral aspect, short, may reach posterior pygofer margin, broad basally, with slender and ventrally bowed body, dentifer slender and bowed dorsad, with apical region sharply curved dorsad and tapered sharply to form pointed apex; in ventral aspect, convergent mesad, body slender,

with 4 short, thin setae on outer lateral margin, divergent near base of dentifer, dentifer with 9 teeth on ventromedial margin, apex strongly curved laterad. Aedeagus, in ventral aspect, base slender, with shaft slightly wider than base, atrial area around gonopore expanded, atrium narrowed and apex concave.

Material studied: 10 males //KSU greenhouse/ 11-IX-1986// (KSU),
1 male //Sand dunes/ Medora, Kans// Jul 4// D.A. Wilbur/ Coll 1930// (KSU),
2 males //Jul 12// Riley Co/ Kansas// Ac. 3555/ Sp// (KSU), 1 male
//Collected in/ Sec. T. Wind Trap// Arlington/ Va 7-27-32// F.W. Poos/ Coll//
(KSU), 1 male //Manhattan, Ks/ 1929 June 13// D.A. Wilbur/ Coll// (KSU),
4 males //Jul 12// Riley Co/ KANSAS// (KSU), 1 male //Jul 20// EE Faville/
Riley Co KS// (KSU), 1 male //July 17// JB Norton/ Riley Co Ks// (KSU),
1 male //Sand dunes/ Medora, Kans// Jul 4// D.A. Wilbur/ Coll 1930// (KSU),
1 male //Manhattan, Ks/ 1 Sept. '25// Coll. alfalfa// RC Smith/ Collector//
(KSU), 1 male //Jun 5// PJ Parrott/ Riley Co Ks// (KSU), 1 male //May 18//
Cempe/ 5 Folia [sic]// (KSU), 1 male //Fulton Miss/ 7-14-30/ L.D. Tuthill//
(KU). Location of type unknown to author.

E. fabae appears to be related to salivae. These species have similar sternal IV apodemes, basally connected anal hooks that are short and broad, triangular pygofer, setal patterns on the plates, styles with few setae, and apical region of styles directed dorsad. E. fabae is distinct in the presence of a short sternal II apodeme and an apically expanded brachone.

Empoasca (Empoasca) sativae Poos
Figure 18.

Empoasca sativae Poos, 1933a

Empoasca (Empoasca) sativae: DeLong and Knull, 1946a

Body length: 2.56 - 3.04 mm; crown length: 0.16 - 0.20 mm; crown
production: 0.08 - 0.10 mm; interocular width: 0.30 - 0.36 mm; pronotal
length: 0.24 - 0.34 mm; pronotal width: 0.62 - 0.70 mm.

Sternal apodeme II attains segment 6 - 7 (length: 0.32 - 0.49 mm,
width: 0.23 - 0.40 mm), with margins subparallel to broadly rounded or quadrate
apices. Sternal IV apodeme a narrow transverse ridge. No tergal apodemes present.
Brachone, in lateral aspect, extends to posterior margin of pygofer, slender,
expanded near apex, constricted at apex, with apical region a fingerlike process,
apex triangular; in ventral aspect, basal region convergent mesad, with body
slightly curved laterally, apical region slightly convergent and slender, fingerlike
process. Anal hook bases connected, with broad, flat plate, spine-shaped apex
directed ventrad or slightly ventrocephalad.

Pygofer posterior margin triangular, with 4 - 6 short, slender setae. Plate,
in lateral aspect, with caudodorsal lobe; A-group setae 3, short, thin; B-group
setae 18, at least twice as short as A-group, thin; C-group setae 16 - 18, long,
thick, triserrate; D-group setae 16 - 18, long, thin; no basal pegs. Style, in
lateral aspect, short, does not reach posterior margin of pygofer, broad basally,
with slender, ventrally bowed body, dentifer short and broad, with apex directed
dorsad; in ventral aspect, convergent mesad, body slender, with 3 short, thin setae
on outer lateral margin, divergent near base of dentifer, dentifer with 7 teeth on
ventromedial surface, apex strongly curved laterad. Aedeagus, in ventral aspect,

base slender, with shaft slightly wider than base, atrial area around gonopore expanded, atrium narrowed and apex concave.

Material studied: 1 male //Santa Rita Mts./ Ariz. 6-12-33/ R.H. Beamer// (KU), 3 males //Jeff Davis/ Tex 7-8-33// (KU), 2 males //Nogales Ariz./ 6-25-33/ R.H. Beamer// (KU), 1 male //Chiricahua Mts/ Ar. 7-8-32/ R.H. Beamer// (KU), 1 male //Concan Tex/ 7-6-36/ R.H. Beamer// (KU), 1 male //Brownsville/ Tex 6-29-38/ R.H. Beamer// (KU), 1 male //Jeff Davis/ Tex 7-8-33// (KU), 2 males //Patagonia Ariz./ August 21, 1935/ R.H. Beamer// (KU), 1 male //Miami Ar./ 7-22-32/ R.H. Beamer// (KU), 1 male //Miami Ar./ 7-22-32/ R.H. Beamer// (KU), 1 male //Tucson Ariz./ 8-16-35/ Jean Russell// (KU), 1 male //At light/ Trap A// Arlington/ Va 9-11-33// FW Poos/ Coll// (KSU). Holotype male and paratypes No. 49933 reported to be deposited in the USNM. Paratypes reported to be deposited in OHSU.

E. sativae appears to be related to fabae. These species have similar similar sternal IV apodemes, basally connected, short, broad anal hooks, triangular pygofer, setal patterns on the plates, styles with few setae, and the apical region of the styles directed dorsad. E. sativae is distinct with a long sternal II apodeme and an apically slender and fingerlike brachone.

LITERATURE CITED

- Anufriev, G. A. 1978. Les Cicadellides de le territoire maritime. In M. S. Ghilarov & A. F. Emeljanov (Eds.) Academie des sciences de l'urss., Hor. Soc. Entomol. Union. Sovet. Vol. LX (In Russian).
- Cunningham, H. B. 1962. A phylogenetic study of the leafhopper genus *Empoasca* (Homoptera, Cicadellidae). Ph.D. dissertation, Univ. of Illinois, Urbana.
- Ghauri, M. S. K. 1974. The *solana*-group of *Empoasca* Walsh (Homoptera, Cicadellidae): its generic status and a new species from pawpaw. Bull. Entomol. Res. 63:425-429.
- Hamilton, K. G. A. 1972. The leafhopper genus *Empoasca* subgenus *Kybos* in the southern interior of British Columbia. J. Entomol. Soc. Brit. Columbia. 69:58-67.
- _____. 1983. Classification, morphology and phylogeny of the family Cicadellidae (Rhynchotha:Homoptera). pp. 15-37. In Proceedings, 1st International Workshop on Biotaxonomy, Classification and Biology of Leafhoppers and Planthoppers (Auchenorrhyncha) of Economic Importance, London.
- Langlitz, H.O. 1964. The economic species of *Empoasca* in the Coastal and Sierra Regions of Peru. Revta. peru. Ent. agric. 7: 54-70.
- Metcalf, Z. P. 1967. General catalog of the Homoptera. Fascicle VI, Cicadellidae. Part 17, Cicadellidae. U.S. Dept. Agr., Agr. Res. Ser.: 286-597.
- Ross, H. H. 1963. An evolutionary outline of the leafhopper genus *Empoasca* subgenus *Kybos*, with a key to the Nearctic fauna (Hemiptera, Cicadellidae). Ann. Entomol. Soc. Am. 56:202-223.
- Sohi, A. S. 1983. The Oriental Typhlocybinae with special reference to pests of cotton and rice: a review. pp. 47-74. In Proceedings, 1st International Workshop on Biotaxonomy, Classification and Biology of Leafhoppers and Planthoppers (Auchenorrhyncha) of Economic Importance, London.
- Sohi, A. S. & I. Dworakowska. 1983. A review of the Indian Typhlocybinae (Homoptera: Cicadellidae) from India. Oriental Insects. 17:159-213.
- Southern, P. S. 1982. A taxonomic study of the leafhopper genus *Empoasca* (Homoptera: Cicadellidae) in Eastern Peru. North Carolina Agr. Res. Ser. Tech. Bull. 272.

- Viraktamath, C. A. 1983. Genera to be revised on a priority basis. The need for keys and illustrations of economic species of leafhoppers and preservation of voucher specimens in recognised institutions. pp. 472-492. In Proceedings, 1st International Workshop on Biotaxonomy, Classification and Biology of Leafhoppers and Planthoppers (Auchenorrhyncha) of Economic Importance, London.
- Young, David A. 1952b. A reclassification of western hemisphere Typhlocybinae (Homoptera, Cicadellidae). The Univ. of Kansas Science Bull. Vol. XXXV, Pt. I, No. 1.
- Zachvatkin, A. 1953. Cicadina from Trans-Volga sand areas, Astrakhan. pp. 225-236. In Almanac of Scientific Works, Moscow.

Legend of Morphological Features

- a. -- male abdomen, ventral aspect
- b. -- head and pronotum, dorsal aspect
- c. -- male genital capsule, lateral aspect
- d. -- aedeagus, lateral aspect
- e. -- male genital capsule, ventral aspect
- f. -- abdominal tergal apodemes, dorsal aspect
- g. -- aedeagus and anal hooks, ventral aspect
- h. -- aedeagus, ventral aspect
- i. -- brachone, lateral aspect
- j. -- style, lateral aspect
- k. -- aedeagus, lateral aspect
- l. -- anal hook, lateral aspect
- m. -- pygofer, lateral aspect
- n. -- plate, lateral aspect
- o. -- head, dorsal aspect

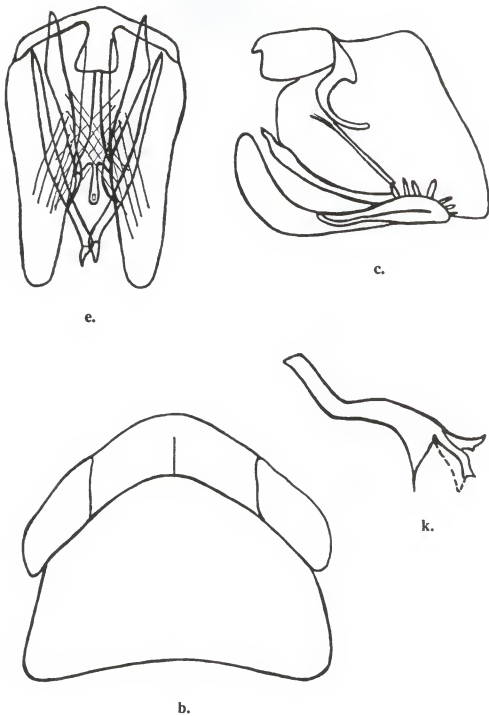


Figure 1. *Kybos grosata* (DeLong and Davidson)

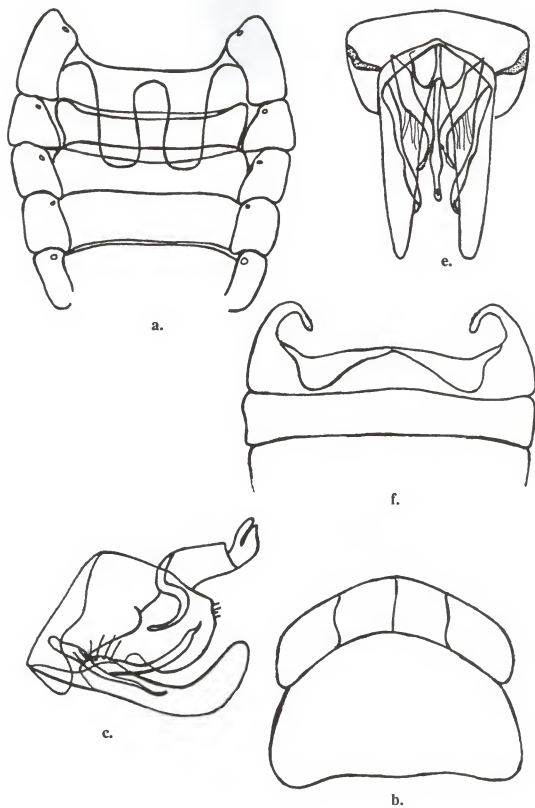


Figure 2. *Kybos gelbata* (DeLong and Davidson)

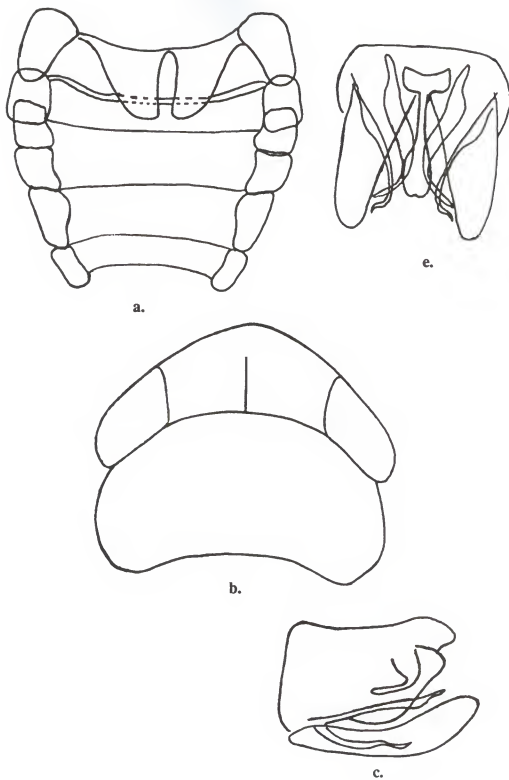


Figure 3. *Kybos jacinta* (DeLong and Davidson) -- 12x magnification

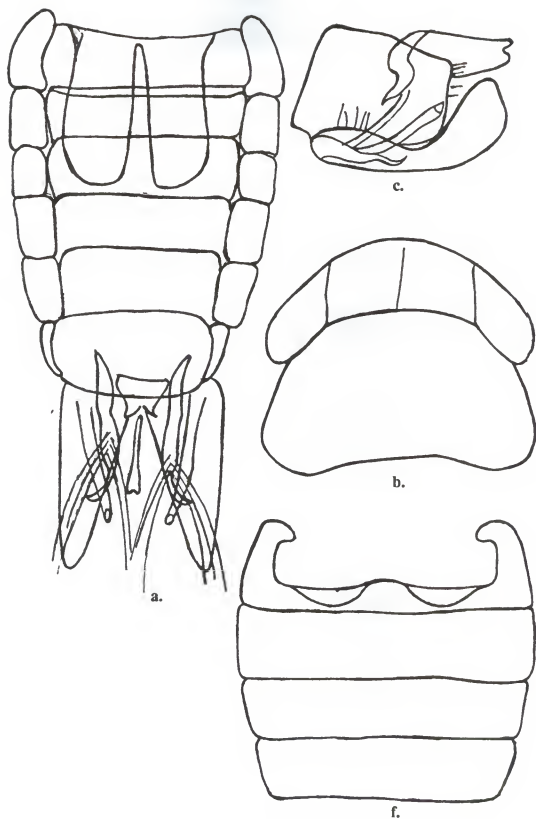


Figure 4. *Kybos obtusa* (Walsh)

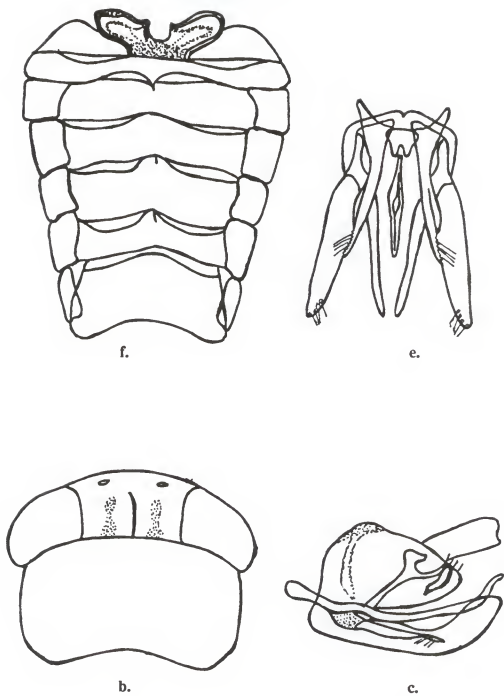
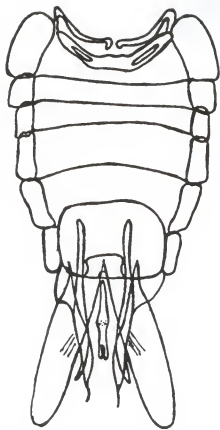
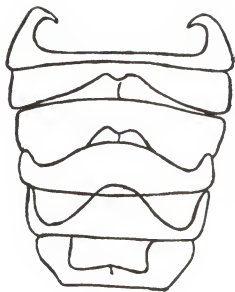


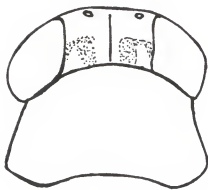
Figure 5. *Kyboasca denticula* (Gillette)



a.



f.



b.



c.

Figure 6. *Kyboasca pergandei* (Gillette)

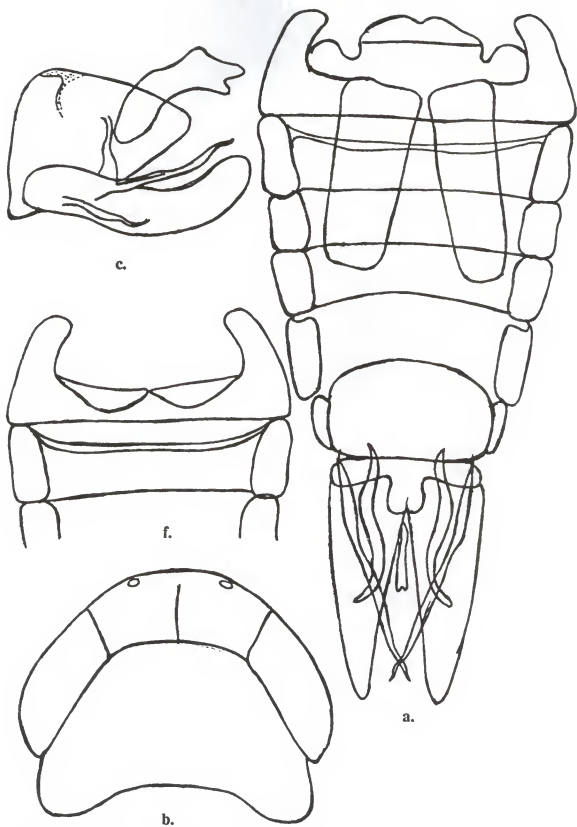


Figure 7. *Empoasca (Solanasca) solana* (DeLong) -- 12x magnification

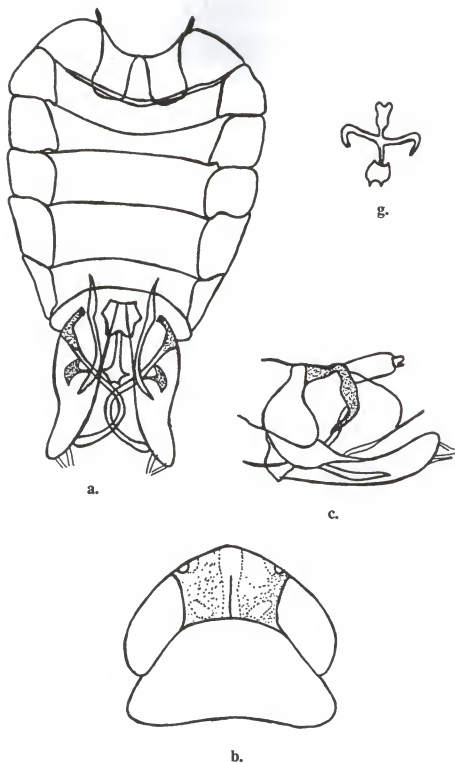


Figure 8. Empoasca (s. str.) (decurvata) Davidson and DeLong

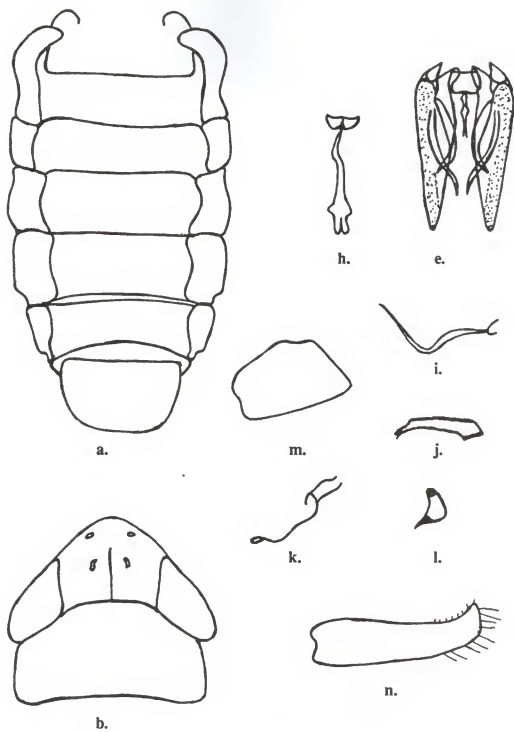


Figure 9. *Empoasca* (s. str.) *curvata* Poos

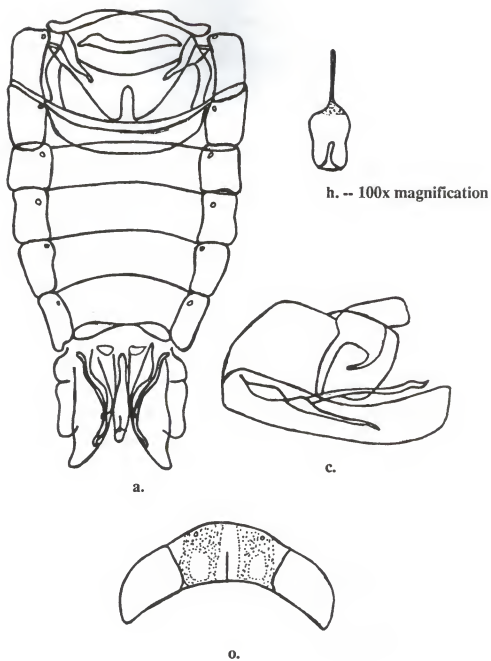


Figure 10. Empoasca (s. str.) alboneura Gillette

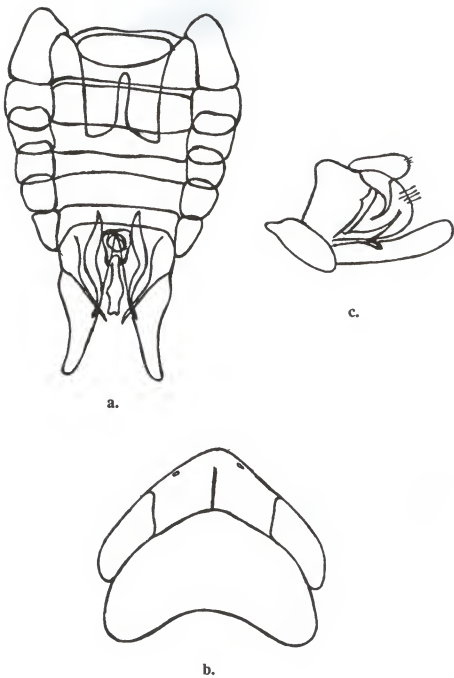


Figure 11. Empoasca (s. str.) esuma Goding

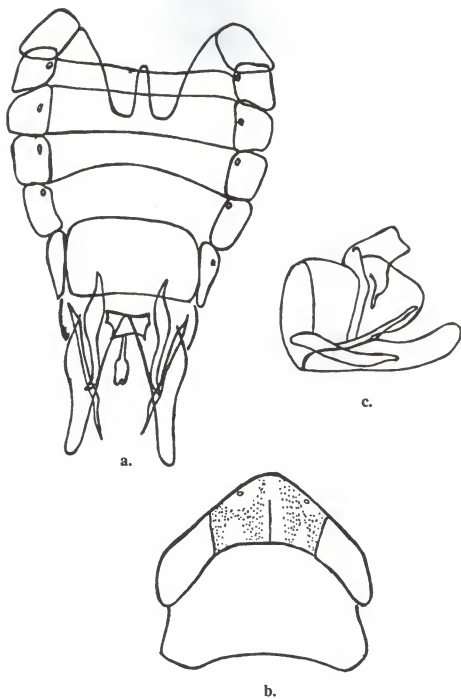
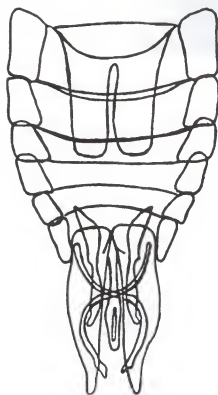


Figure 12. *Emposasca* (s. str.) *vergena* DeLong and Caldwell



a.



c.



h. -- 12x magnification



b.

Figure 13. Empoasca (s. str.) bifurcata DeLong

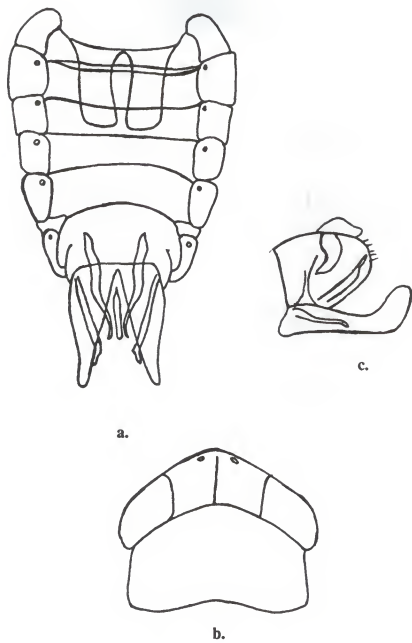


Figure 14. *Empoasca* (s. str.) *grigeron* DeLong

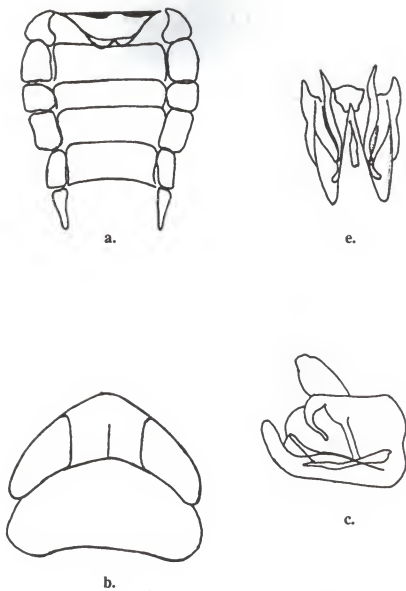


Figure 15. *Empoasca* (s. str.) *recurvata* DeLong

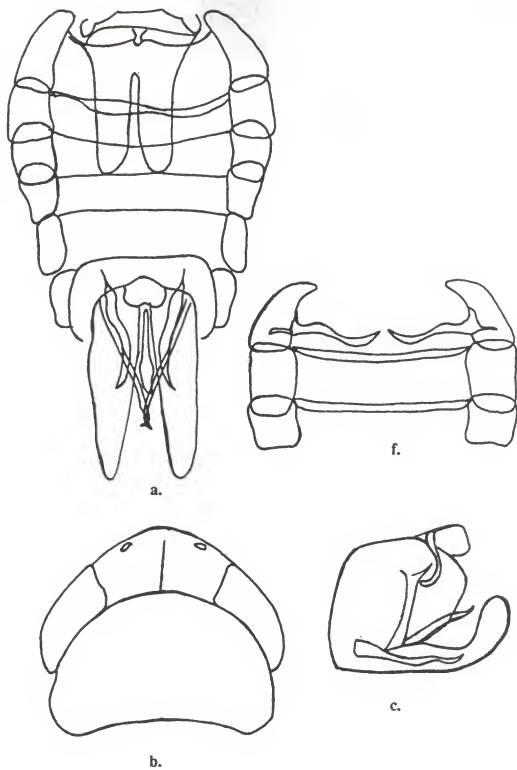


Figure 16. *Empoasca* (s. str.) *pallida* Gillette

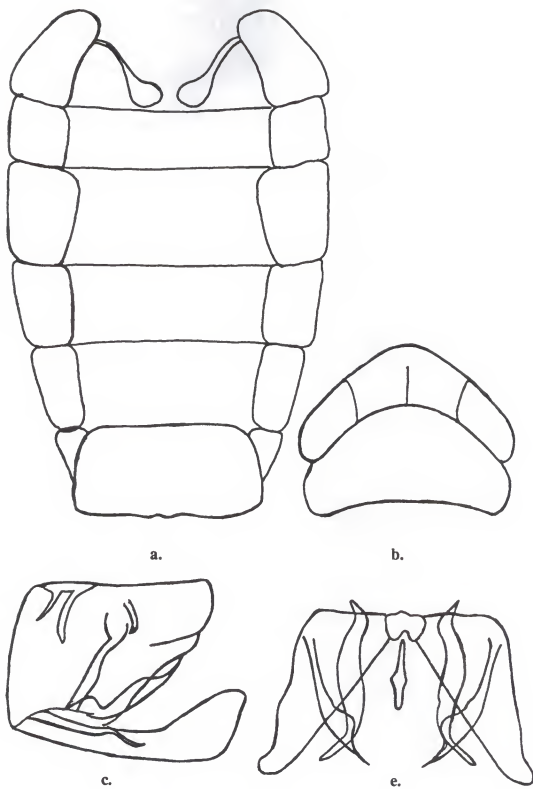
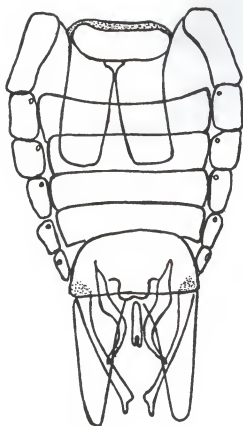


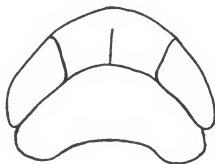
Figure 17. *Empoasca* (s. str.) *fabae* (Harris) -- 12x magnification



a.



c. -- 12x magnification



b.

Figure 18. Empoasca (s. str.) sativae Poos

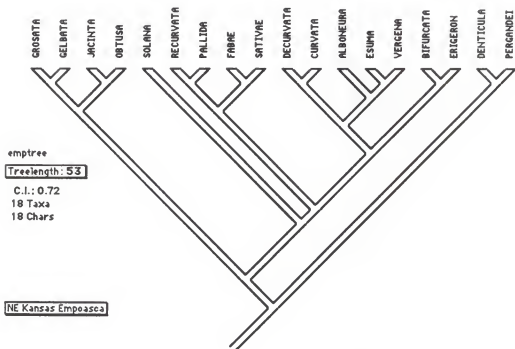


Figure 19. Intuitive phylogeny graphically represented using MacClade

APPENDIX A.
PHYLOGENY DEVELOPED USING CLINCH

Species relationships using CLINCH are represented in the following figure.

Characters and polarity are the same as those used in my intuitive phylogeny.

The only difference in the data matrix used in CLINCH is that CLINCH does not accept weighted characters. CLINCH did verify genus groups but other relationships suggested by CLINCH are different from those I propose. Inability to weight characters using the CLINCH program results in what I consider may be two major incorrect phylogenetic relationships. First, Kybos may be incorrectly represented as a paraphyletic group to Empoasca. Second, incorrect interspecific relationships within Empoasca may be suggested.

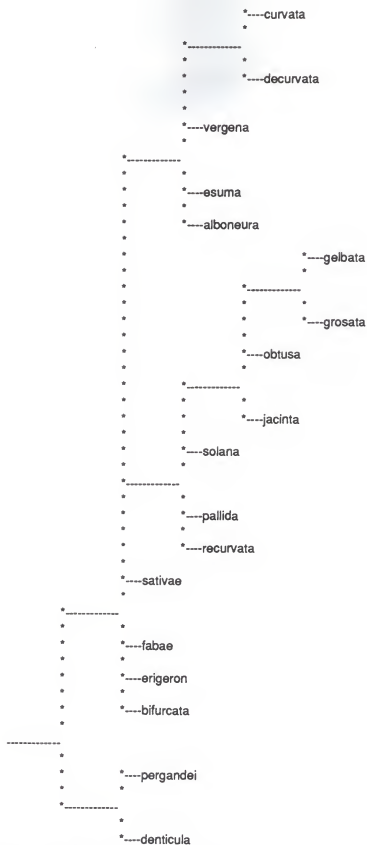


Figure 20. Phylogeny developed using CLINCH.

A REVIEW OF THE GENUS EMPOASCA (HOMOPTERA:
CICADELLIDAE) REPORTED FROM NORTHEAST KANSAS

by

Roxanne A. Fegley

A.S., Jamestown Community College, 1984

B.S., State University of New York at Fredonia, 1986

AN ABSTRACT OF A MASTER'S THESIS

submitted in partial fulfillment of the

requirements for the degree

Master of Science

College of Agriculture
Department of Entomology

Kansas State University
Manhattan, Kansas

1989

ABSTRACT

Leafhoppers of the genus Empoasca have a virtually world-wide distribution. This study represents a review of Empoasca reported from Northeast Kansas. Two closely related genera from Northeast Kansas, Kyboasca and Kybos, were included for outgroup comparisons. Included in this study are the following species: Kyboasca denticula (Gillette) and pergandeji (Gillette), Kybos grosata (DeLong and Davidson), gelbata (DeLong and Davidson), jacinta (DeLong and Davidson), and obtusa (Walsh), Empoasca (Solanasca) solana (DeLong) new status, E. (Empoasca) decurvata Davidson and DeLong, curvata Poos, alboneura Gillette, esuma Goding, vergana DeLong and Caldwell, bifurcata DeLong, erigeron DeLong, recurvata DeLong, pallida Gillette, fabae (Harris), and sativae Poos. Phylogenies were based on characters used by previous authors and my intuitive determination. CLINCH output was of assistance in verifying genus groups and MacClade was of assistance in graphically representing my intuitive phylogeny.